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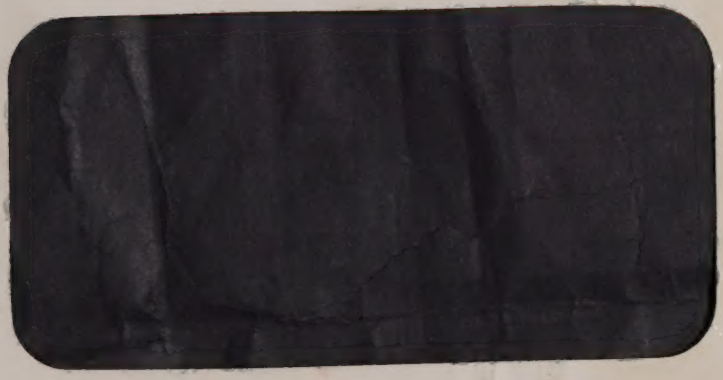

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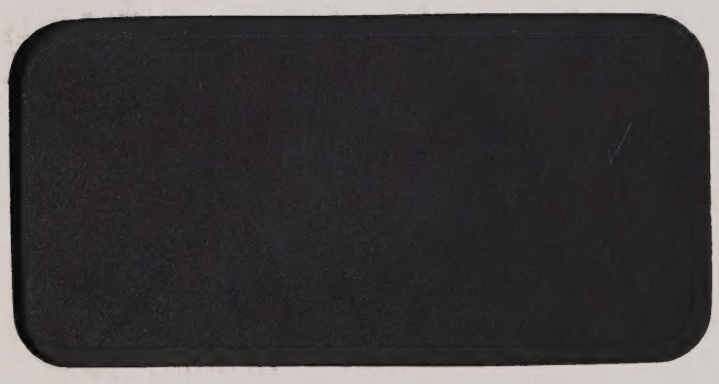

Gould 2608
Digital Storage Oscilloscope
Operators Manual

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Contents
Introduction
Getting Started 1
Advanced Features 2
The Menus 3
Performance Checking 4
Options 5
Alphabetical Summary 6
Error Messages A1
Specification A2
Glossary A3
Floating Inputs A4
RS423 to PC Interfacing A5
RS423 & GPIB Pin–outs A6
Front Panel & GPIB Equivalents A7
Front Panel Picture A8
Index
Service Facilities

Introduction 1
1. Getting Started 2
1.1 Safety and Power Requirements 2
1.1.1 International Safety Warning 2
1.1.2 Floating Input Ratings 2
1.1.3 Grounding 2
1.1.4 Live Parts 2
1.1.5 Ventilation and Dust 2
1.1.6 Operating Temperatures 2
1.1.7 Power & Frequency Requirements 2
1.1.8 Fuse Requirements 2
1.2 Floating Inputs 4
1.3 Using the Buttons 4
1.4 Start-Up Display 4
1.5 Obtaining a Trace 4
1.5.1 AUTO SETUP 5
1.5.2 Channel Selection (Off/On/Inv) 5
1.5.3 Coupling 5
1.6 Horizontal Adjustments 6
1.6.1 TIME/DIVISION 6
1.6.2 Aliases 6
1.6.3 Position 6
1.6.4 Magnification 6
1.7 Vertical Adjustments 7
1.7.1 VOLTS/DIVISION 7
1.7.2 Position 7
1.7.3 Variable/Uncalibrated 7
1.7.4 Add 8
1.8 Manually Obtaining a Trace 8
1.9 Operating Hints 9
1.9.1 Intensities too low 9
1.9.2 Trace off the top or bottom of screen
1.9.3 Trace not being acquired 9
1.9.4 Trace unstable 9
1.9.5 Trace has flat top or bottom 9
1.9.6 Auto setup fails 9
1.9.7 Traces appear noisy 10
1.9.8 Cursor measurements wrong 10
1.9.9 Top or bottom of trace missing 10

2. Advanced Features 11
2.1 Trigger Control 11
2.1.1 Trigger Source 11
2.1.2 Dual Trigger 11
2.1.3 Trigger Coupling 11
2.1.4 Level 12
2.1.5 Slope (+/-) 12
2.1.6 Trigger Mode (Auto/Norm) 12
2.1.7 External Trigger Input 12
2.2 Trigger Delay 12
2.2.1 Pre-Trigger 13
2.2.2 Delay by Time 14
2.2.3 Delay by Events 14
2.2.4 Divide by N 14
2.3 Capture Facilities 15
2.3.1 Trace Hold 15
2.3.2 S/Shot and Run 15
2.4 Display Modes 15
2.5 Cursor Measurements 16
2.5.1 Cursor and Datum Selection 16
2.5.2 The Cursor & Datum Lines 16
2.5.3 Making Measurements 16
2.6 Using Floating inputs 16
2.6.1 Signal Connections and Safety 16
2.6.2 Common Mode Rejection 17
2.7 Plot 17
2.7.1 Internal Color Plotter 17

3. The Menus 19
3.1 Menu Buttons 20
3.1.1 The Numeric Buttons 20
3.1.2 0: Menu/Traces 20
3.1.3 Master 20
3.1.4 9: Display 20
3.1.5 Variable V/Div 20
3.1.6 Split Screen 20
3.2 Master Menu 20
3.3 Status Menu 21
3.4 Acquisition/Trigger Menu 22
3.5 Display Menu 23
3.6 Save/Recall Control Settings Menu 24
3.7 Plot Menu 25
3.8 Special Functions Menu 26
3.9 Date and Time Menu 27
3.10 RS423 Menu and GPIB Menu 28
3.11 Option Function Menu 28
3.12 Display Controls Menu 29
3.13 Variable V/Div Menu 29
3.14 Split Screen Menu 30

4. Performance Checking 31
4.1 Risetime 31
4.2 Bandwidth 31
4.3 Trigger Sensitivity 31
4.4 Trigger Bandwidth 32
4.5 Timebase Calibration 32
4.6 Vertical Calibration 32

5. Options 33
5.1 Plotters 33
5.1.1 Color Plotter 33
5.1.2 RS423 & GPIB Plotting 33
5.2 Communication via GPIB/RS423 33
5.3 GPIB and RS423 Commands 38
5.3.1 GPIB/RS423 Command Summary 38
5.3.2 GPIB/RS423 Command Detail 40
5.4 Waveform Processor 58
5.4.1 Waveform Processor Operation 58
5.4.2 Programmable Sequences 69
5.4.3 Waveform Processor GPIB/RS423 Command summary 75
5.4.4 Waveform Processor GPIB/RS423 Command Detail 77

6. Alphabetical Summary of Front Panel Controls 90

Appendix 1: Error Messages 93
Appendix 2: Specification 94
Appendix 3: Glossary of Terms 97
Appendix 4: Discussion on Floating Inputs 98
Appendix 5: RS423 to PC Interfacing 101
Appendix 6: RS423, GPIB & Misc Pin-outs 102
Appendix 7: Front Panel & Menu GPIB Equivalents 103
Appendix 8: Front and Back Pictures 107

Index 109

Service Facilities 114

FIGURE LIST

1.2 Floating Input connections
1.3a Single Function Buttons
1.3b The Toggles
1.3c The Paddles
1.4 Start-up Display
1.5 Obtaining a Trace
1.5.1 An Auto Set-up Display
1.6 Horizontal Controls
1.6.2 Alias Generation
1.7 Vertical Controls
2.1 Trigger Controls
2.1.2 Delay Trigger Operation
2.2a Trigger Delay Controls
2.2b Trace Capture with Delay
2.2.4a Typical waveform for delay by events
2.2.4b Possible trace displays from figure 2.2.4a
2.3 The Capture Controls
2.5.2 The Cursor and Datum Lines
2.5.3 The Cursor and Datum Line Controls
2.7.1 Color Plotter Paper Loading
3.0 The Menu Structure
3.1 The Numeric Buttons
3.2 The Master Menu
3.3 A Status Menu
3.4a An Acquisition/Trigger menu with delay by time
3.4b Acquisition/Trigger menu with delay div by N
3.5 A Display Menu
3.6 The Save/Recall Menu
3.7a Plot Menu
3.7b Plot Menu
3.7c RS423 Typical interface cable connections
3.8 The Special Functions Menu
3.9 The Date and Time Menu
3.10a The RS423 Menu
3.10b The GPIB Menu
3.11 The Option Function Menu
3.12 The Display Controls Menu
3.13 The Variable V/Div Menu
5.4.1 Standard V/T Measurement
5.4.2 V wrt V at Time Datum
5.4.3 T to Last Crossing Point
5.4.4 FFT Options Menu
5.4.5 Trace Arithmetic Menu
5.4.6 Risetime Measurement
5.4.7 Overshoot Measurement
5.4.8 Pulsewidth Measurement
5.4.9 Frequency, Period & Duty Cycle Measurement
5.4.10 Max-Min Measurement
5.4.11 Peak to Peak Measurement
5.4.12 Area Measurement
5.4.13 Reference Memory Options

A4a Single Ended Input
A4b Floating Input
A4c Input Impedance Graph
A4d Input Isolation
A4e 8 Channel Input Isolation
A4f Possible Earth Loops
A4g Earth Loops Isolated

A6a RS423 Connector Pin–out
A6b GPIB (IEEE–488) Connector Pin–out

A7a Front Panel GPIB Equivalents
A7b Menu GPIB Equivalents

A8a Numbered Front Panel Controls

Introduction

About the 2608

The Gould 2608 instrument is a Digital Storage Oscilloscope. It includes all the features expected of an advanced modern oscilloscope designed for the professional engineer, whilst retaining the user-friendliness essential for those learning to use such an instrument for the first time.

The 2608 has eight independently isolated input channels to provide great flexibility and ease of use. Obtaining a trace is especially simple - just connect the signal and press the Auto Setup button - the 2608 does the rest. Having obtained a trace, readily accessible datum lines and a cursor make it easy to take automatic timing and voltage measurements directly from the display.

More advanced features of the 2608 include a dual trigger mode and the pre-trigger display function which allows the signal *prior* to the trigger point to be captured and displayed.

About this Manual

This manual contains information on all of the operational features of the 2608 Digital Storage Oscilloscope. For servicing information refer to the Servicing Manual.

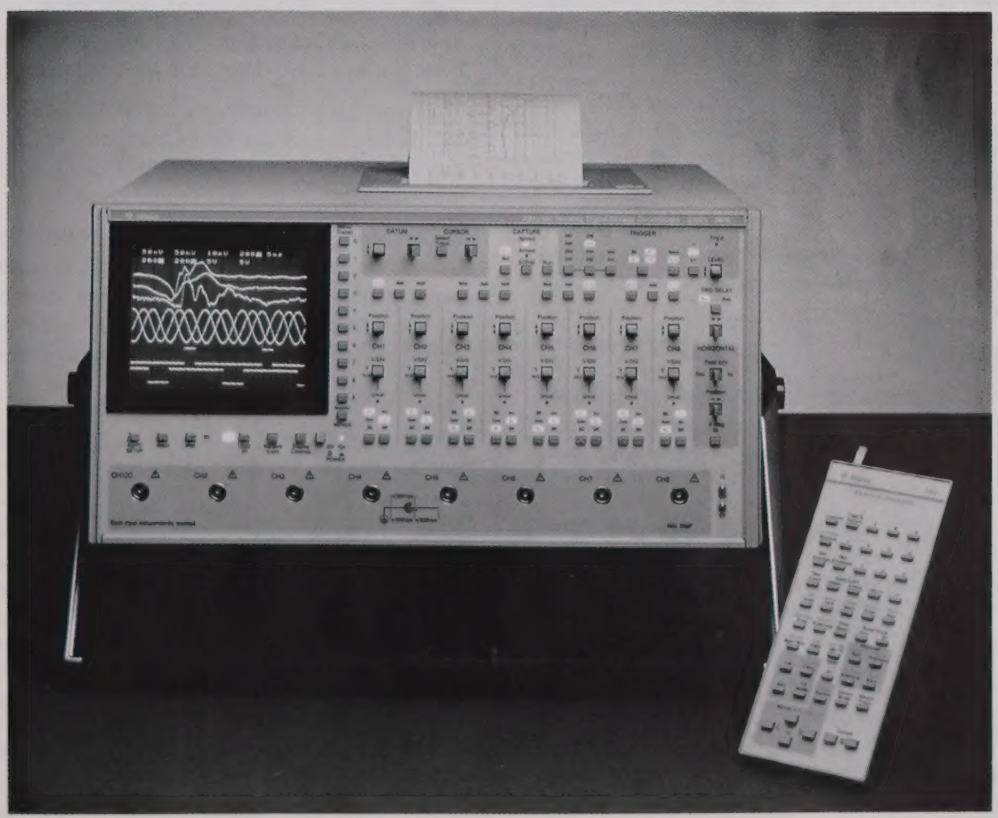
Section 1.1 must be read and note taken of its contents before using the oscilloscope.

The manual is split into various sections that allow both the novice and advanced user to find basic and more advanced operating information.

Section 1 contains basic information on standard operating features using the front panel controls, section 2 details more advanced features available from the front panel controls and section 3 explains the further features that are accessed by using the menu system.

Section 4 provides instructions for basic performance checking, section 5 has details of options that are available for the 2608 and includes details of the GPIB and RS423 commands. Section 6 is a summary of all the front panel controls.

Numbers circled in the text refer to the controls shown on the fold out front panel picture in appendix 8.



1.1 Safety, Environmental and Power Requirements

1.1.1 International Safety Warning
(as required for I.E.C. 348 Cat I)

This manual contains information and warnings which must be observed to keep the instrument in a safe condition. The instrument should not be switched on if it is damaged and it should not be used under wet conditions.

1.1.2 Grounding

The instrument must be operated with a protective ground connected via the yellow/green conductor of the supply cable. This is connected to the instrument before the line and neutral connections when the supply plug is inserted into the the socket on the back of the instrument. If the final connection to the supply is made elsewhere, ensure that the ground connection is made before line and neutral.

Signal connections to the instrument should be connected after the ground connection is made and disconnected before the ground connection or removed, i.e the supply lead must be connected whenever signal leads are connected.

1.1.3 Isolated Input Connections

The floating signal inputs to the 2608 are all independently isolated from each other and from the instrument ground. Each input is protected against input voltages of up to 500V peak maximum from Input to Common, Input to Ground, and Common to Ground. This voltage must not be exceeded under any circumstances.

WARNING: Even low voltage inputs may carry high voltage fast transients (spikes) which could damage the input and make the instrument unsafe. For this reason it is not safe to make direct connections to an AC line supply.

Because each input's common connection is not grounded, the use of non approved connectors could allow the operator to touch lethal signals. See section 2.6.1.

1.1.4 Live Parts

The instrument must not be operated with covers removed. The covers protect the user from live parts and they should be removed only by suitably qualified personnel for maintenance and repair purposes.

WARNING: Removing the covers may expose voltages in excess of 8.5KV at the side of the display tube; these may be present for up to one minute after the instrument has been disconnected from the power source.

1.1.5 Ventilation and Dust

The instrument relies on forced air cooling via a fan and ventilation slots. Adequate ventilation can usually be achieved by leaving a 75mm (3") gap around the instrument. Care should be taken to avoid restricting the airflow to the fan at the rear of the instrument.

The instrument should not be operated in dusty environments.

The fan filter should be regularly cleaned to prevent a build up of dust restricting the airflow. To remove the filter, ensure that the instrument is turned off and unclip the retaining cover and filter assembly from the rear of the instrument. The filter can then either be cleaned, by blowing through with compressed air, or replaced with a new one, Gould part number 458814. Re–assembly is the reverse of the above procedure.

If the CRT filter requires cleaning it can be easily removed by pressing in its right hand edge.

1.1.6 Operating Temperatures

The instrument is designed to be operated in an environment having an ambient temperature of between 0 and 50 degrees C, and to operate with full accuracy between 15 and 35 degrees C.

Note: *Direct sunlight, radiators and other heat sources should be taken into account when assessing the ambient temperature.*

1.1.7 Power and Frequency Requirements

The instrument uses less than 200VA and operates from nominal line voltages of 100V, 120V, 220V or 240V, at 45 to 440Hz. The instrument will still operate correctly even if there is a half cycle dropout in the line supply.

The power connection is via a standard IEC, CEE 22 connector. Before connecting the instrument to the supply, ensure that the rear panel supply voltage selector is set to the appropriate voltage.

Access to the voltage selector and fuse can only be made if the supply connector is removed, and is by hinging open the panel connector from its top edge. The selector barrel can then be moved to the required setting. The supply fuse must be changed to suit the supply voltage as shown in table 1.1.8.

1.1.8 Fuse Requirements

The fuse arrangement shown in table 1.1.8 must be followed, and additionally in the UK, a 3A fuse should be fitted in the line supply plug.

Supply Voltage	Slow–Blow Fuse Rating IEC (UL/CSA)	Gould Part No	Suggested types Manufacturer/ Type No.
220/240V	0.5A (0.6)	457452	Beswick/TDC488, Littlefuse/239, Schurter/FSP.
100/120V	1A (1.2A)	457454	Beswick/TDC488, Littlefuse/239, Schurter/FSP.

Table 1.1.8 Fuse ratings

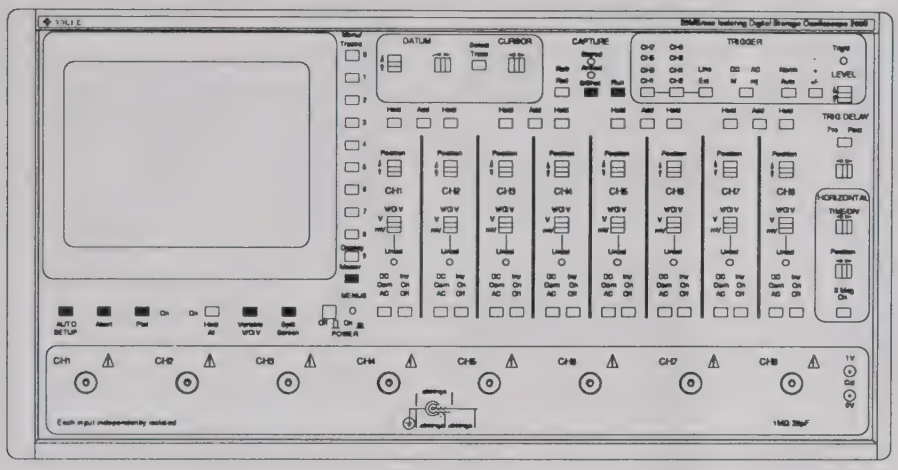


Figure 1.3a Single Function Buttons

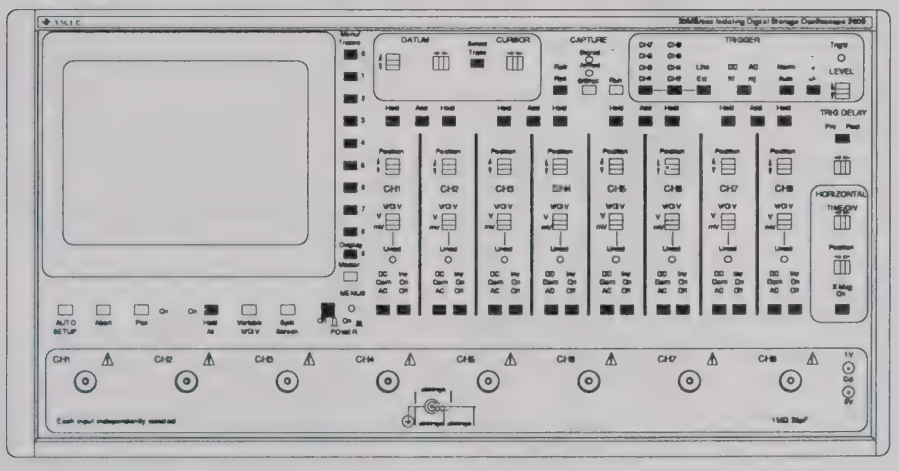


Figure 1.3b The Toggles

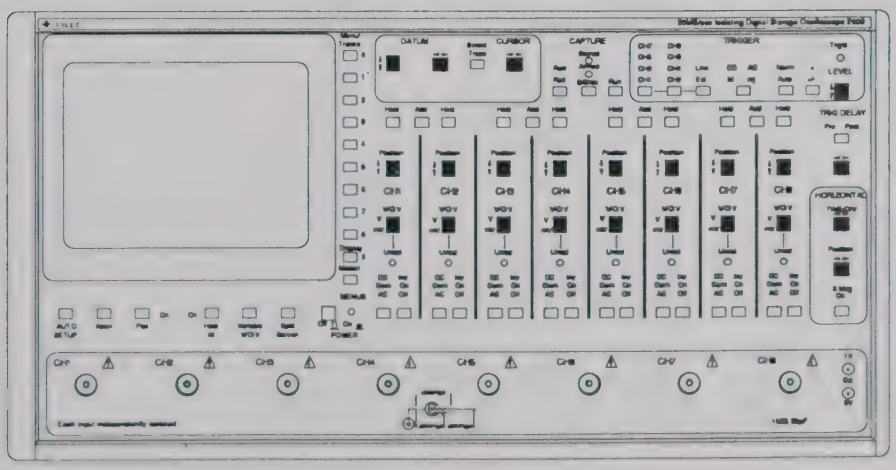


Figure 1.3c The Paddles

1.2 Floating Inputs

Floating inputs consist of a high impedance (input) connection and a low impedance (common) connection capacitively coupled to ground.

The floating inputs on the 2608 are isolated to 500V. This means that both the common and the input can float up to 500Vpk referenced to ground.

The input connection is the center pin on the connector and the inner ring is the common connection. The outer ring and probe connector body are connected to the instruments ground. See figure 1.2

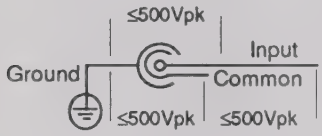


Figure 1.2 Isolated Input Connections.

Care should be taken to avoid voltages greater than 500Vpk between any two of the three points - input, common and ground – on the input connector. See sections 1.1.3 and 2.6.1

1.3 Using the Buttons **see appendix 8**

There are three types of buttons on the 2608. The first type usually have only one function: when pressed, that one function will be activated e.g. **AUTO SETUP** (48). See figure 1.3a.

The second type are toggles: each press of the button either switches something on or off e.g. **Add** (4), or selects the next item in a sequence e.g. **Off/On/Inv** (34). See figure 1.3b.

The third type are double action paddles: the effect caused depends upon how hard the paddle is pressed. For example a gentle push of a **Position** paddle (32), up or down, will move the trace slowly. If the paddle is pushed further, the trace will move more quickly. See figure 1.3c.

1.4 Start-Up Display

When switched on with the **POWER** button (39), the instrument will display information similar to that shown in Figure 1.4.

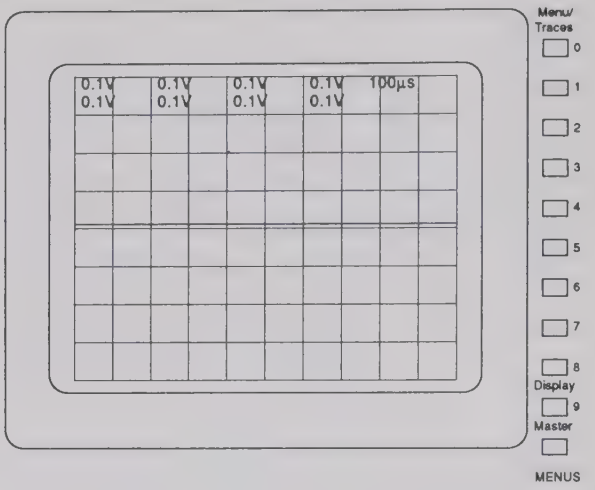


Figure 1.4 Start-Up Display

The trace is visible across the center of the screen. At the top will be the sensitivities of the input channels and the time-base speed. If any channel is inactive, information for that channel will not be displayed.

Users with no previous experience of a DSO will find that the 2608 responds like a conventional Real Time Oscilloscope while it is repetitively triggered, but in the absence of further valid triggers, it will retain the last trace for continuous display.

1.5 Obtaining a Trace

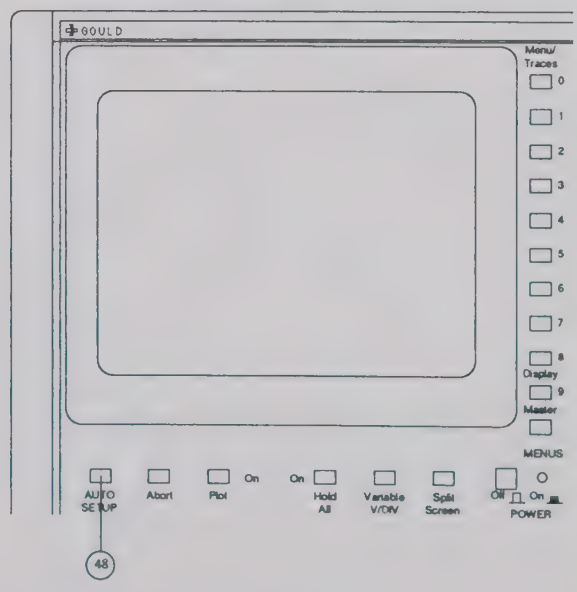


Figure 1.5 Obtaining a Trace

1.5.1 AUTO SETUP

To display an input signal, connect it via any of the channel input sockets (27), (28), (30), (33), (36), (40), (44) or (47) and press **AUTO SETUP** (48). Assuming a repetitive signal with a frequency between 20Hz and 7MHz at an amplitude between 5mV and 40V has been applied, e.g a 2kHz sine-wave with an amplitude of 5V peak to peak, it will almost immediately be represented on the display. An example is shown in figure 1.5.1.

If the display is very dim or has completely disappeared see section 1.9.1

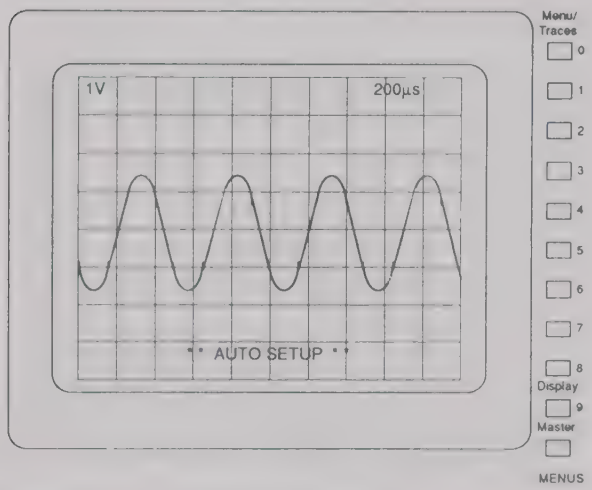


Figure 1.5.1 An AUTO SETUP Display

AUTO SETUP will attempt to arrange the display so that two to five complete cycles appear, with the amplitude set so that the height of the trace is between two and five screen divisions. Auto trigger is selected to ensure that the screen is frequently updated and that a trace will be visible.

If more than one channel has a signal connected, the lowest channel number will take priority for triggering and timebase selection.

Whenever possible, Auto Setup will try to use the split screen facility to display traces. See section 3.14.

The split screen mode will only be activated during Auto Setup if it would result in at least half of the split screen windows for a given compression ratio containing a trace. Auto setup does not allow there to be more than one trace per window.

If Auto Setup uses split screen mode, all the displayed channels will be set to the same compression ratio.

e.g. if there are signals on channels 1, 2 and 3 then split screen will not be activated because, for the signals to use more than half the split screen windows, the compression ratio must be either ÷2 or ÷4. If ÷2 were selected all the traces would appear in the same window and if ÷4 were selected then the signals from channels 1 and 2 would be in the same window.

If these same signals were connected instead to channels 1, 3 and 5, Auto Setup would use ÷4 and each trace would appear in its own window.

1.5.2 Channel Selection (Off/On/Inv) (34)

A channel may be switched on or off with its **Off/On/Inv** button. If the channel is on, its trace can be displayed in either normal or inverted mode.

Off The channel is deactivated.

On The trace is a true representation of the input signal.

Inv The input signal is inverted before being displayed. If there is any DC component in the signal this will also be inverted and could cause the trace to disappear off the screen. Such an unwanted DC component can be removed by selecting AC coupling. Any vertieal shift applied to the trace is not inverted. The trigger point remains at the same point on the waveform regardless of inversion.

1.5.3 Coupling (AC/Com/DC) (35)

These buttons control the type of coupling between the input signal and the instrument. DC is the most generally applicable, and **AUTO SETUP** will normally set this control to DC where possible.

The channel impedance, input to common, is 1MΩ in parallel with a capacitance of 35pF.

AC This is used to remove any DC component from input signals. Suitable input signals - i.e. the bandwidth - are from 4Hz to 7MHz.

Com The input signal is internally disconnected from the input amplifier. The amplifier input is shorted to common. Each channel's common line is isolated from all the other channels.

This mode is equivalent to Ground on other oscilloscopes, however high frequency signals on the common, could breakthrough and be displayed on the screen due to the finite common mode rejection ratio of the instrument. See section 2.6.

DC The input signal is directly coupled to the instrument so that all frequency components of the input signal will be displayed. The bandwidth will be from DC to 7MHz.

1.6 Horizontal Adjustments

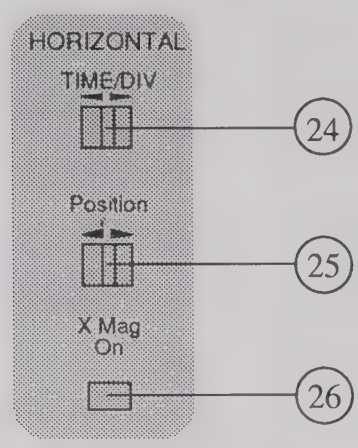


Figure 1.6 Horizontal Controls

1.6.1 TIME/DIVISION

Paddle (24) controls the sweep rate of the traces. The timebase can be varied from 50µs/div to 200s/div in a 1, 2, 5 sequence of values. Pushing the paddle towards 'ns' decreases the time/div,and towards 'sec' increases the time/div. Since the memory length is fixed, this changes the sample rate of the oscilloscope.

The 2608 takes 10,000 samples per horizontal sweep therefore there are 1000 samples per division. The time between samples can be obtained by dividing the time per division by 1000.

With a timebase of say 200µs, each horizontal screen division represents 200µs worth of signal. consisting of 1000 samples per division with a time between samples of 200ns i.e. a sample rate of 5MHz. The timebase selected is shown near the top of the display - e.g. 200µs.

Assuming a 2kHz signal is applied as mentioned earlier, when the timebase is set to 500ms/div, an interesting phenomenon may appear: an 'alias'.

1.6.2 Aliases

An alias is a false image. The instrument is a digital oscilloscope and so takes frequent samples of the input signal in order to update the trace. If the signal frequency is higher than the sample frequency, one sample will be taken from a particular point on the wave form and the next sample may be taken from a point slightly further along on a subsequent cycle. It will then display the wave as being much slower than it really is. See figure 1.6.2. This effect will occur if the sample rate is less than twice the frequency of the input signal.

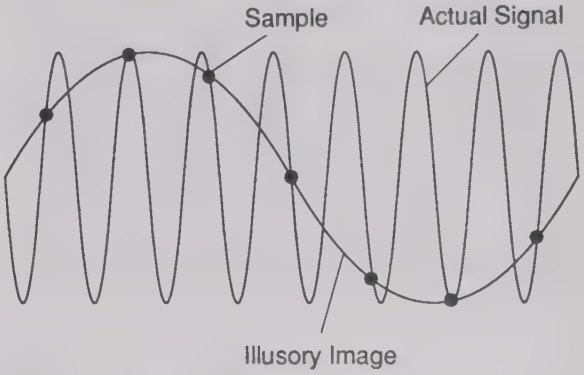


Figure 1.6.2 Alias Generation

There is a Max/Min glitch detection feature which can be used to detect aliases. With dot join on, this usually results in a filled-in wave envelope being seen on the screen, indicating a high frequency. See section 3.4

1.6.3 Position

The position paddle (25) moves all the traces to the left or right relative to the graticule.

The position of the cursor - section 2.5 - is fixed in relation to the traces so it will move with the applied shift. With X-Magnified traces - section 1.6.4 - ,the cursor can be off the part of the trace displayed on the screen. To bring it back into view use the cursor paddle (7).

1.6.4 Magnification

The timebase can be magnified by a factor of; x2, x5, x10, x20, x50, x100 or x200. The magnification is turned on using the X-Mag On button (26). When magnification is turned on the magnification factor can be set by pressing button 1 and stepping through the choices until the required one is reached.

When X-Mag is active the selected expansion factor is applied to all active traces which then expand around the center of the screen. The alphanumeric display of the timebase setting is adjusted to reflect the expansion, and the expansion factor is shown below the timebase readout.

If the message "WILL XMAG WHEN READY" appears, this means that although the display is showing a trace, the acquisition memory has not yet acquired all the data required for an updated display and so the instrument cannot yet show an expanded trace.

If the cursor is on, selecting X-Mag may cause the cursor to move off the screen. It can be brought back into view using the cursor paddle (7).

When the 2608 captures a signal, it stores 10K data points for the waveform in the acquisition store. The instrument has a display store of 1K data points and under normal non-expanded conditions the stored 10k data points are compressed to 1K by transferring every tenth point from the acquisition store to the display store to produce the trace. This results in a display with 100 dots - samples - per screen division.

When an expansion factor is selected only part of the complete stored waveform can be viewed at any one time on the display, so only part of the acquisition store is relevant.

At an expansion of x10, only one tenth of the complete waveform can be seen, so only one tenth of the acquisition store is required i.e. 1K data points. In this case every data point from the area of interest is transferred to the display store. This still results in a display with 100 samples per division.

At greater expansions less of the acquisition store is required resulting in fewer samples per division e.g. at an expansion of x100 there are ten samples per division. At these higher magnifications the individual samples become visible.

1.7 Vertical Adjustments

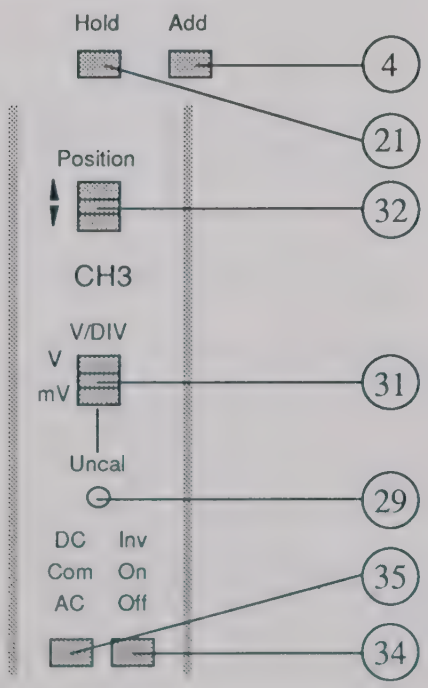


Figure 1.7 Vertical Controls

1.7.1 VOLTS/DIVISION

Paddle (31) adjusts the vertical sensitivity of the relevant channel of the instrument over discrete calibrated steps from 10mV to 5V per screen division in 1, 2, 5 steps. With probes other than x1 the probe tip ranges are shown in table 1.7.1. See also section 3.4

Probe	Range		
x1	10mV	to	5V/div
x10	100mV	to	50V/div
x100	1V	to	500V/div
x1000	10V	to	5000V/div

Table 1.6 Probe Tip Voltage Ranges

If the **Uncal** light is on, then the **V/Div** paddle varies the sensitivity of the signal input continuously. The sensitivity of the Common is not varied. See section 1.7.3.

1.7.2 Position

The position paddles (32) move their respective traces up and down the display relative to the graticule.

When split screen mode is active the position paddle will only move the channel within its compressed window. See section 2.4.1. Any part of a compressed waveform that is shifted outside its window will not be displayed on the screen, possibly causing the trace to appear as a series of separate segments.

If **Hold Trace,** or **Hold All** is on or a single shot capture has been made - see section 2.3 - and a trace subsequently shifted vertically, any part of the trace that was captured off screen vertically will be shown by a horizontal line.

1.7.3 Variable/Uncalibrated

When the **Variable V/DIV** button (42) is pressed, the display changes to show each channel alongside the appropriate numeric button. Any of the channel inputs can then be set to uncal by pressing its number. The coarse setting of the vertical attenuator is unchanged but a variable attenuation is applied to the input signal in the range of 2.5:1. Thus with an initial setting of 1V, the actual sensitivity of the channel could be set by this control to anywhere between 1V and 2.5V per division. The **V/DIV** paddle is used to vary the uncalibrated sensitivity.

In order to change the coarse setting of the V/Div, Uncal should be turned off. The range can then be changed using the V/DIV paddle (31). When the required coarse setting has been obtained, turn uncal back on again and the V/DIV paddle reverts to the variable sensitivity control.

When Uncal is selected the display alongside the channel numeric button changes from, CAL to UNCAL, the relevant uncal light (29) illuminates and a > symbol is placed in front of the V/div readout on the screen.

This feature can be useful to calibrate an input signal to be a certain number of divisions e.g. the output from a sensor can be set to give a full scale trace for 100% input.

1.7.4 Add

The **Add** button (4) is used to display the sum, or if one channel is inverted, the difference of the relevant channel pair 1&2, 3&4, 5&6 or 7&8 in place of both the original traces.

Channels are added after the signals have been digitized therefore both traces must be on the display before pressing **Add.**

When channels are added, a plus sign appears between the channel settings at the top of the display.

If **Add** is on and **XY** mode is subsequently selected, the Add mode will be cancelled.

1.8 Manually Obtaining a Trace

This section describes how to obtain a trace without using **AUTO SETUP.**

Later sections of the manual may need to be consulted as not all of the operating features have yet been described.

1. When switched on, the instrument will go through its power-up sequence, checking the internal calibration.
2. Decide to which channel the input signal is to be applied. - CH1 to CH8.
3. Ensure that the chosen channel is active by setting the **Off/On/Inv** button (34) for that channel to On.
4. Set the **AC/Com/DC** button (35) for the chosen channel to Com.
5. If necessary, turn that channel's **Uncal** light out by pressing **Var** and selecting uncal using the numeric keys.
7. Make sure that horizontal mag is not selected and that the X-Mag indicator is off. If the indicator is on, press the X-Mag switch (26).
8. Adjust the **TIME/DIV** paddle (24) to give a timebase of 100ms.
9. Set the display mode (8) to **Refr.**
10. Set trigger **Auto/Norm** (17) to Auto.
11. Use the trigger source buttons (13), (14) & (15) to select the required source for the trigger signals.
12. Set the trigger coupling with button (16).
13. Ensure that both **Trace Hold** (21) and **Hold All** (43) are off.
14. If necessary, adjust the position of the trace using the **Position** buttons (25) and (32).
15. Select **Run** (12).
16. Apply the signal through an input connector to the chosen channels input socket. (27), (28), (30), (33), (36), (40), (44) or (47).
17. Set the **AC/Com/DC** button (35) to either AC or DC as appropriate.
18. Adjust the gain of the chosen channel using the **V/DIV** paddle (31). For intermediate settings, select **Uncal** on by pressing the **Variable V/DIV** button (42) once and selecting the appropriate channel with the numeric keys.
19. Adjust the timebase setting to suit the signal using the **TIME/DIV** paddle (24).
20. If the display is unstable, adjust the trigger **Level** paddle (20).

1.9 Operating Hints

This section contains some hints and tips about the more commonly met problems in operating Digital Storage Oscilloscopes. A brief description of what was wrong together with how to correct the problem is given. Later sections of this manual may need to be consulted as some of the operating features have not yet been discussed.

1.9.1 Problem: Traces and alphanumerics very dim or completely disappeared.

Intensities too low.
- Press the **Display** button (37) to get the Display Controls menu, then press numeric button **3** to increase the brightness of the alphanumerics on the display. Numeric button **1** can now be used to increase the intensity of the traces.

Note: The display may not become visible until numeric button 3 has been pressed several times.

1.9.2 Problem: Trace off the top or bottom of the screen.

Too much vertical shift.
- Correct with that channel's **Position** paddle (32).

Input has large DC offset.
- AC couple the input signal using button (35).
- Correct with the **Position** paddle (32).
- Use a less sensitive vertical range, button (31).

1.9.3 Problem: Trace not being acquired.

Instrument in single capture mode.
- Press **Run** (12).

Trigger level incorrect.
- Select **Auto** and **DC** trigger, buttons (17) and (16), then adjust the level control until the trigger level indicator bars are lined up with the center of the trace.

Trigger Source on the wrong input.
- Change the trigger source using buttons (13) or (14).

Trigger coupling on an unsuitable setting.
- Change trigger coupling using button (16).

Long trigger delay set.
- Either wait for delay to end, or shorten trigger delay.

Channel **Hold** or **Hold All** on.
- Release Hold using button (21) or (43).

Timebase on very slow acquisition.
- Adjust horizontal **Time/Div** (24).

1.9.4 Problem: Trace is unstable even when triggered.

Alias.
- Check for alias using Max/Min (glitch detection), and select a faster timebase range.

Noisy input.
- Select **Hf rej** triggering (16).
- Adjust trigger level (20).

Band trigger selected on unsuitable signal.
- Deselect band triggering (18).
- Adjust trigger level (20).

Dual trigger selected on unsuitable signal causing double triggering.
- Deselect dual triggering (see section 3.4).
- Adjust trigger level (20).

Trigger on Auto.
- With very low frequency inputs (below 20Hz), **Auto** trigger will initiate triggers over–riding the input triggers. Select **Norm** trigger (17).

1.9.5 Problem: Trace has very flat top or bottom.

Trace captured when off screen vertically and **position** shift has been used.
- Use less sensitive **V/Div** range when acquiring trace (31).
- Re–position trace prior to capture.

1.9.6 Problem: Auto Setup fails.

Signal not repetitive.
- Use less sensitive **V/Div** range when acquiring trace (31).

Signal amplitude too small or too large.
- Use different amplitude signal.

Signal frequency too slow or too fast.
- Use different rate signal.

Signal not constant.
- Use different stable signal.

High frequency noise on signal.
- Use different cleaner signal.

Band Trigger selected.
- Deselect band triggering (18).

1.9.7 Problem: Traces appear very noisy.

High frequency signals present on common.
- Re-connect common to a low frequency (less than 60Hz) reference voltage.

Common not connected.
- Connect common to a reference voltage.

1.9.8 Problem: Cursor measurements wrong.

Wrong probe gain selected.
- Select correct probe gain to suit probe in use. See section 3.4.

Datum not set correctly.
- Re–position datum on trace.

Cursors on wrong channel trace.
- Position cursors on trace of interest.

1.9.9 Problem: Sections of trace missing on display.

Trace in split screen mode and position paddle has been used to reposition trace in compressed window.
- Re–position trace in window.
- Turn off split screen mode.

2. ADVANCED FEATURES

This section of the operators manual explains in detail how to use the more advanced features of the 2608.

2.1 Trigger Control

The 2608 DSO has very comprehensive trigger facilities; those discussed here are available directly from the front panel. For the more advanced menu driven features see section 3.2.2 Acquisition/Trigger menu.

A Trigger starts ALL channel sweeps simultaneously and is a single event. The trigger controls determine when this event occurs.

When the instrument receives a valid trigger, the trigger lamp (20) briefly illuminates. When a continuous sequence of valid triggers are received, the trigger lamp is continuously illuminated.

When the instrument is turned off, the current trigger settings are retained and will be used on power up.

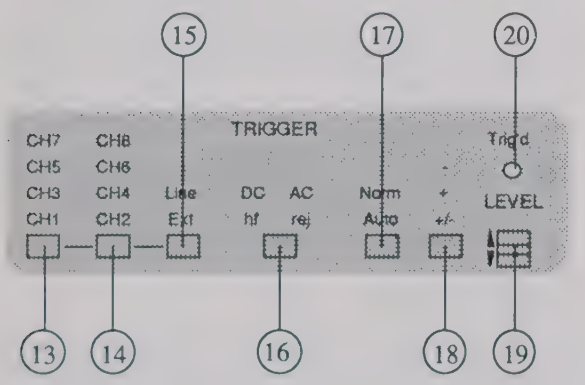


Figure 2.1 Trigger Controls

2.1.1 Selecting Trigger Source.

Buttons (13), (14) and (15) determine the source from which the trigger circuit takes its input. Buttons (13) and (14) are used to select an input channel while button (15) selects either line or external. Only one of the LEDs above the source buttons will be illuminated to indicated the trigger source. If line is selected, the trigger circuitry synchronizes to the line supply. The external trigger signal should be connected to the BNC connector labeled **EXT** on the rear of the instrument.

2.1.2 Dual Trigger

A simple OR trigger facility is provided which is activated through the menu system – see section 3.4. When selected, two channels can be selected using buttons (13) and (14), the signals from the two selections are then OR'd to provide a single trigger signal. If either of the two selected channels crosses the trigger level, the DSO will be triggered.

This facility is useful when it is not known which of two possible trigger events will occur first.

One LED from each of the columns above buttons (13) and (14) will be illuminated to show which channels are selected.

There is only one trigger level indication available. It will accurately show the trigger level including any shift and inversion on the odd channel only.

Note *The same trigger level is used for both channels and if one channel remains above the trigger level, trigger events from the second channel will be ignored. See figure 2.1.2.*

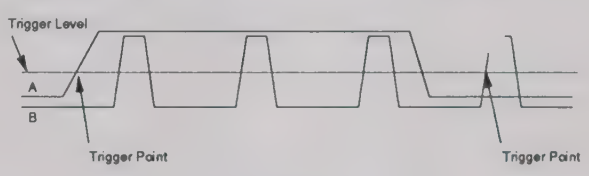


Figure 2.1.2 Dual Trigger Operation

In the example shown in figure 2.1.2, the first positive going edge of signal A and the fourth positive going edge of signal B will generate a trigger. The first three positive going edges of signal B will not generate triggers because signal A is still above the trigger level.

When dual trigger mode is turned off, the even channel trigger will be inhibited and the even channel indicator will be turned off. i.e. the trigger source will revert to the selected odd channel.

Dual trigger mode will become inactive if line or ext are selected as trigger sources. When a channel is selected as the trigger source again, the second channel of the previously selected pair of channels will also be reactivated.

2.1.3 Trigger coupling

Button (16) selects the coupling used for the trigger signal. Each press of the button moves the selection on one step through the sequence: AC, AC Hf Rej (High frequency reject), DC, DC Hf Rej, etc.

The High frequency reject option switches in a low pass filter set to 15KHz. Using this filter is helpful in stabilizing the trigger point on noisy input signals.

2.1.4 Trigger level

The trigger level is set by the **LEVEL** paddle (20). This has five positions; fast up, slow up, no change, slow down and fast down. An indication of the trigger level relative to the displayed trace is shown by two small horizontal bars one at each side of the display. In Band Trigger 4 bars are shown, two on each side of the screen.

The trigger coupling must match the channel coupling for the trigger level bars to be meaningful. The trigger level bars give an approximation of the trigger level and should only be used as a guide to the trigger point

When the level control has been set so that valid trigger signals are being detected, the **Trig'd** lamp (19) lights up.

The first sample point after the trigger is displayed slightly brighter than the rest of the trace.

When the split screen mode is on, several operations of the trigger level paddle may be required to see any change of the trigger level indicator on the screen. The trigger level is changing with each operation but the screen resolution may not show the change.

2.1.5 Trigger Slope

A trigger is generated when the selected source signal passes through the chosen trigger level. This crossing point can be on either a rising or falling edge. The rising edge is considered to be a positive slope and the falling edge a negative slope.

The trigger point can be selected to be on either the positive going edge (+) or the negative going edge (–) by selecting the required option using button (18). Each successive press of this button selects the next choice in the sequence –, +, +/– etc.

The +/– choice is a trigger band indicated by two sets of level bars at the sides of the display. When a positive going edge passes through the upper level or a negative going edge passes through the lower level a trigger will be generated The position of this band is moved using the **LEVEL** paddle (20) and the size of the band can be changed using numeric keys 2 and 3. Key 2 increases the size and key 3 decreases it.

The trigger band facility can be used for example to trigger on a spike on a supply line when it is not known whether the spike is positive or negative going. In this case the band would be set such that the trace from the supply lies within the band so that either polarity spike would fall outside the band and cause a trigger.

2.1.6 Trigger mode (Auto/Norm)

The trigger system can operate in two modes; Auto or Normal.

In Normal mode, display captures can only occur when a valid trigger signal has been received.

In Auto mode, if no valid trigger signal has been received in 33ms, the instrument will automatically produce its own trigger signal and initiate a capture. This ensures that the screen is constantly updated regardless of the input signal.

If valid triggers are received at a rate of 30Hz or more, they will be used to start all captures and the instrument will not generate its own triggers.

2.1.7 External Trigger Input

Trigger signals may be connected to the BNC socket labeled **EXT** on the rear panel of the DSO. If **EXT** is then selected using button (15), these signals will be used as the trigger source.

When External trigger is selected, the trigger level is referenced to the center of the screen. i.e. if the coupling is DC then the trigger is referenced to ground and if the coupling is AC then the trigger is referenced to the center of the signal. The trigger level bars have a sensitivity of 1V per division.

CAUTION Signals connected to the EXT socket should not be more than ± 250V peak. Larger signals could cause damage to the internal circuitry.

2.2 Trigger delay

The amount of data that is acquired for display before or after the trigger is determined by the pre or post trigger delay selected. See figure 2.2b. The post trigger delay can be one of three types; Delay by events, delay by time or divide by N. The delay in all cases is set using the five position delay paddle (23). The amount of delay is shown in the bottom right hand of the trace display when the delay paddle is pressed.

Either Pre or Post trigger delay is chosen using button (22). Any Pre or Post Trigger amounts set are remembered by the instrument even when they are no longer selected. When either Pre or Post is re–selected, the previously remembered values will be restored.

Post trigger delay is the time between a trigger event being detected and the first sample at the left hand edge of the display.

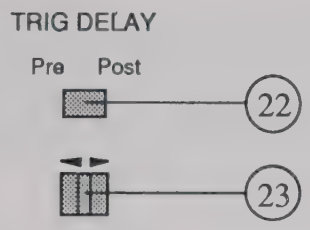


Fig 2.2a Trigger Delay Controls

2.2.1 Pre Trigger

Pre trigger is the ability to capture and display waveforms that occur prior to the trigger point.

Pre Trigger can be used either by pressing the Pre Post button (22) until the Pre lamp is lit or it can be selected in the Acquisition/Trigger menu – section 3.4.

Pre trigger is given as a percentage and can be set from 0 to 100%. With 0% pre trigger the trigger point is at the left hand edge of the screen and 100% puts the trigger point at the right hand edge of the screen. 50% is when the trigger point is in the middle of the screen. i.e. each horizontal division across the screen represents 10% pre trigger.

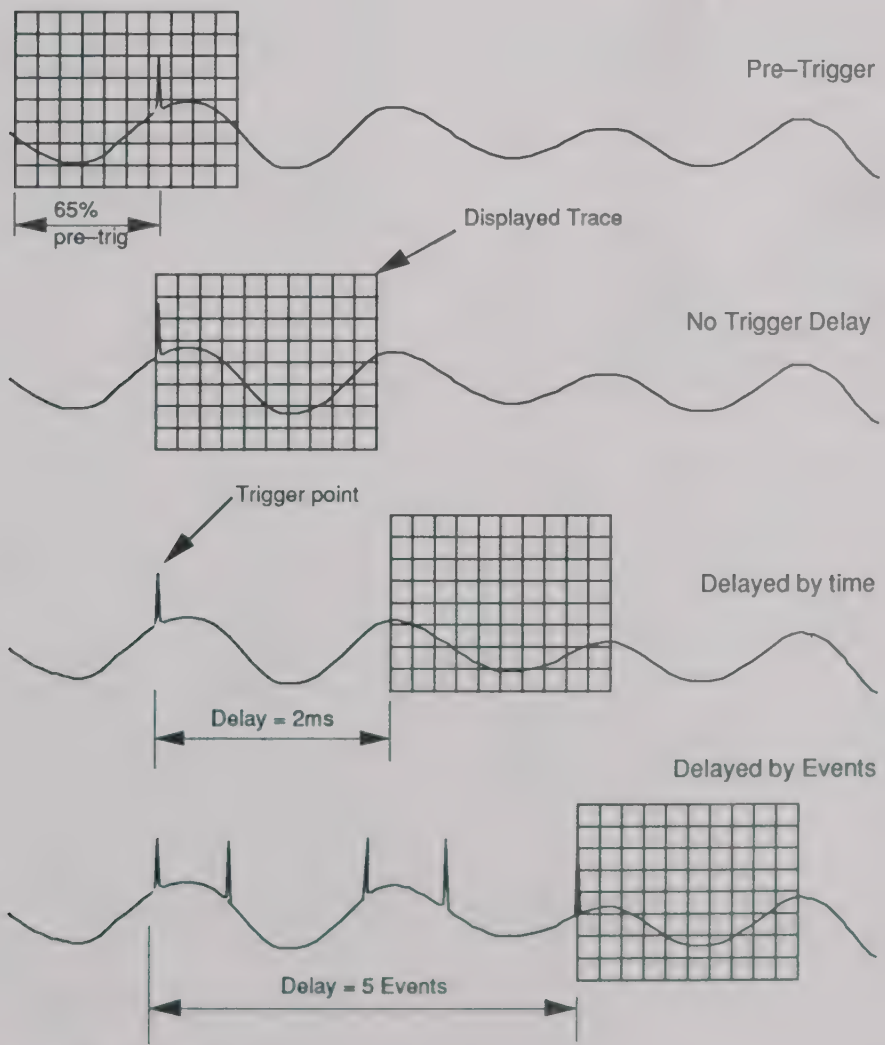


Fig 2.2a Trace Capture with Trigger Delay

The current amount of pre–trigger is shown in the center of the screen while being adjusted with the delay paddle (23), and can also be viewed on the Status menu (section 3.3) and altered on the Acquisition/Trigger menu (section 3.4).

2.2.2 Delay by time

This is set by the Delay paddle (23) when the trigger mode is set to **Post** by button (22) and the Delay by TIME option has been selected in the Acquisition/Trigger menu – See section 3.2.2 – The delay time can be set to an resolution of 50ns, but the size of steps by which the delay can be incremented or decremented is dependent on the current timebase setting. Once set the delay time remains the same regardless of the selected timebase range.

The minimum delay is from zero when the trigger point will be at the left hand edge of the screen. The maximum delay is dependant on the timebase range and is shown below.

50µs to 2ms:	100ms
5ms to 200ms:	10s
500ms to 200s:	1000s
ext:	500,000 clocks

Table 2.2.2 Max delay for timebase ranges

The current trigger delay setting is shown on the screen when the delay paddle (23) is adjusted. The amount set can also be viewed on the Status menu (section 3.3) and altered on the Acquisition/Trigger menu (section 3.4).

2.2.3 Delay by Events

This option allows the user to define the number of trigger events that occur before a trace is acquired. The trigger mode should be set to Post using the Pre Post button (22) and Delay by EVENTS should be set in the Acquisition/Trigger Menu – section 3.2.2.

The number of events can be set from 2 to 16383. The current number is shown in the lower right hand of the screen while being adjusted by the delay paddle (23), and can also be viewed on the Status menu (section 3.3) and altered on the Acquisition/Trigger menu (section 3.4).

When selected, this mode counts the trigger events and then initiates a sweep on the Nth trigger event. The first sample of this will appear at the left hand edge of the screen. Pushing S/Shot (9) starts the count from then. In Run mode the count starts immediately following the end of the previous acquisition.

2.2.4 Divide by N

This is set by the Delay paddle (23) when the trigger mode is set to Post by the Pre Post button (22), and Delay by Divide by N is set in the Acquisition/Trigger menu – See section 3.2.2 – There are two choices of this mode; The delay paddle can adjust the value of N or the phase dependent on the option selected in the Acquisition/Trigger Menu.

If panel control of N is selected, a trace will be acquired every N triggers provided that the capture mode is set to **Run**.

The value of N can be set from 2 to 16383. The current number is shown in the lower right hand of the screen while being adjusted by the delay paddle (22), and can also be viewed on the Status menu (section 3.3) and altered on the Acquisition/Trigger menu (section 3.4).

This mode is useful when the signal has a repeating pattern of triggers, for example a waveform consisting of repeating groups of three pulses as shown in figure 2.2.4a.

If the value of N is set to 3 then the resulting stable display will be a random choice of one of the three pictures shown in figure 2.2.4b. To select the picture required set the panel control option in the acquisition/trigger menu to phase and then use the delay paddle (23) to select the required picture.

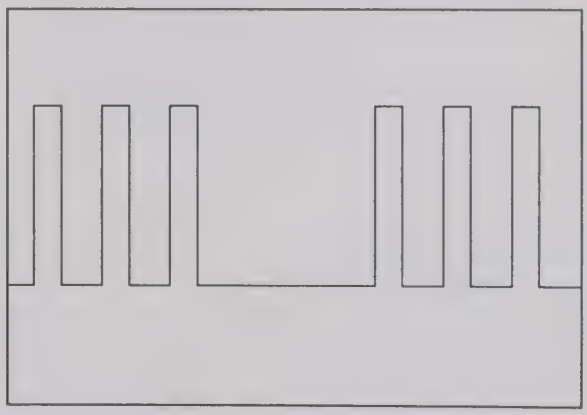


Figure 2.2.4a Typical waveform for delay by events

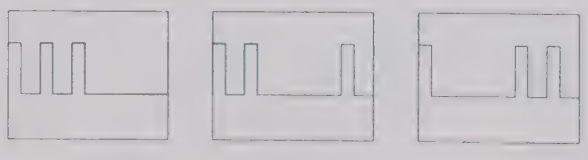


Figure 2.2.4b Possible trace displays from figure 2.2.4a

2.3 Capture Facilities

The capture facilities allow the traces on the 2608 to be frozen.

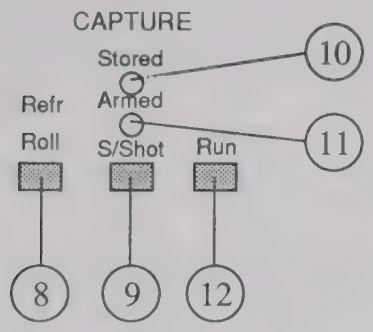


Figure 2.3 The Capture Controls

2.3.1 Trace Hold

There are three ways to hold or freeze the trace displays on the 2608: a single–shot capture whereby a full trace is acquired then frozen – section 2.3.2 –, by pressing the **Hold All** button or by pressing one of the individual channel **Hold** buttons.

Individual channels can be immediately frozen irrespective of the stage of any on-going acquisition by pressing the relevant channel **Hold** button (21). The associated Hold lamp lights to show which channels have been held. To release the trace the **Hold** button should be pressed a second time and the hold lamp will go out. If Add is on when a channel is held then the Added channel is also held.

Pressing the **Hold All** button (43) freezes all the displayed traces immediately regardless of the state of any on-going acquisition. The Hold All On lamp lights to show that all traces have been held. A second press of this button releases all the traces and turns off the Hold All On lamp.

To hold more than one trace at the same instant, press the **Hold All** button (43) then press the **Hold** buttons on the traces that you require. The individual channel hold lamps will illuminate. When all the required channels have been selected, press the **Hold All** button a second time. The selected channels will remain held while the others will be released. To release the held traces, press the relevant channel hold button.

2.3.2 S/Shot and Run

These two buttons (9) and (12) are used to set the instrument into either a capture–and–freeze mode (**S/Shot**), or a free running continuous capture and re-capture mode (**Run**).

S/Shot (9) Arms the instrument for a single–shot triggered acquisition. The armed light will be illuminated to show that the button has been pressed. If it is required that the instrument should remain in this state waiting for a trigger for more than 33ms, then Normal mode – section 2.1.6 – should be selected to prevent Auto triggers being generated.

Armed (10) Illuminates after the **S/Shot** button has been pressed; it will stay lit until either a valid trigger has been received or until the **Run** button is pressed.

Stored (11) Illuminated on completion of a single–shot acquisition. This is after the instrument has been armed, triggered and a complete trace acquired. The light will stay on until the instrument is rearmed by pressing either **S/Shot** again or **Run**.

2.4 Display Modes

There are four display modes on the 2608 DSO: Refreshed, Roll, X-Y and Split Screen. Two of these – Refreshed and Roll are available directly from the front panel. The X-Y mode is selected on the Display Menu, see section 3.5, and the Split Screen mode from the split screen menu, see section 3.14.

Refreshed The instrument will imitate the style of a conventional real-time oscilloscope and the display is plotted from left to right as it is acquired, overwriting existing data. In refresh and pretrigger, the display does not update until the pretrigger information has been acquired.

Roll This mode is like a chart recorder. The display scrolls from right to left until a trace has been acquired. New data is written on the right hand side of the display.

The scrolling effect is most noticeable on the slower timebase ranges. The rolling display is frozen by the trigger in S/Shot mode but is unaffected by the trigger in Run.

Roll is only available on timebases of 200ms/div and slower.

X–Y See section 3.5.

Split Screen See section 3.14.

2.5 Cursor Measurements

The 2608 allows you to take direct measurements from the screen display, using the inbuilt datum and cursor lines.

2.5.1 Cursor and Datum Selection

The cursor and datum lines are switched on or off using the select trace button (6). Successive presses of this button places the cursor and datum lines on to the displayed traces in turn. i.e. channel 1, channel 2, ...channel 8, off, channel 1 etc. If any of the traces are not in use, the lines skip to the next valid selection.

Note: If X magnification is in use, the cursor and datum lines may not be visible on the screen, but this can be easily remedied using the datum and cursor paddles as described below.

2.5.2 The Cursor and Datum Lines

Once activated using the select trace button 3 lines appear on the trace as shown in figure 2.5.2 below. Movement of these lines is achieved using the datum and cursor paddles (3), (4) and (7).

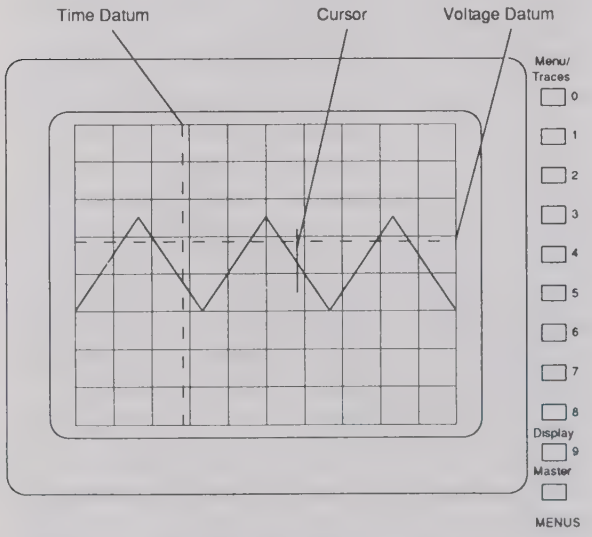


Figure 2.5.2 The Cursor and Datum Lines

All three of these paddles have five positions; fast up or left, slow up or left, no movement, slow down or right and fast down or right.

Paddle 3 moves the Voltage datum line up and down, paddle 5 moves the time datum line left and right and paddle 7 moves the cursor line left and right.

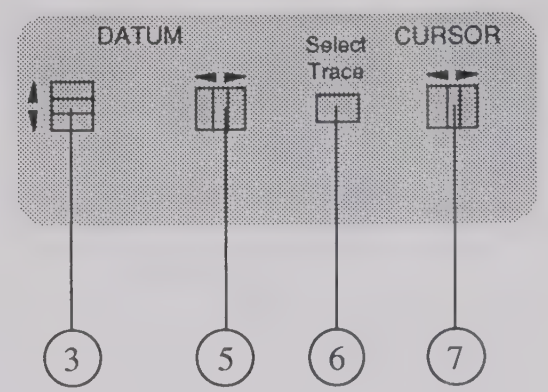


Figure 2.5.3 The Cursor and Datum Line Controls

Both the datum lines extend the full width or height of the display and the cursor is a short line that can be moved along the trace from sample to sample.

2.5.3 Making Measurements

The instrument displays, at the bottom of the screen, the time and voltage difference between the intersection of the horizontal and vertical datum lines and the cursor.

The choice of points between which to make the measurements can influence the accuracy: If a trace is magnified then the cursor can be set more accurately and placed on the required sample.

2.6 Using Floating Inputs

2.6.1 Signal Connections and Safety

Each of the floating inputs is independently isolated from the instrument chassis (ground) and from all the others and is protected to ±500V peak, so that each input can have its common voltage at a different potential.

THE ABSOLUTE MAXIMUM VOLTAGE BETWEEN ANY TWO POINTS OF A CHANNEL'S INPUT MUST NOT EXCEED 500V PEAK. i.e. between Input and Common, Input and Ground or Common and Ground.

Voltages in excess of this could damage the circuitry and make the instrument unsafe.

WARNING: Even low voltage inputs may carry high voltage fast transients (spikes) which could damage the input and make the instrument unsafe. For this reason it is not safe to make direct connections to an AC line supply.

Do not touch the common or input connections. It is recommended that only approved Gould isolated probes, type PB38, are used with this instrument as their connectors prevent the operator from accidentally touching the common or input connections at the instrument end of the probe.

For best performance, the probe common leads should always be connected to the lowest possible impedence point relative to the probe tip.

Users wishing to connect signals other than by probes, should make their own cables terminating at the instrument with LEMO connectors; Gould Part Number 459365.

In situations where isolated operation using the LEMO input connectors is not required, a Gould LEMO to BNC convertor should be used; part number 04101261. This convertor connects the Common terminal to Ground so that the input is no longer isolated, thus it is safe to use a conventional BNC probe or other BNC connected signal.

2.6.2 Common Mode Rejection

Isolated inputs allow measurements to be made with respect to potentials other than ground. e.g. signals with respect to a DC supply line. Isolated inputs can be used to effectively eliminate ground loops which can be a source of both possibly damaging circulating currents and of noise.

The input impedance of the Input with respect to Common, 1MΩ in parallel with 35pF, is similar to that of conventional oscilloscopes. The Common presents a typical capacitance of 200pF with respect to Ground.

This capacitance has negligible effect in most applications with common mode signal frequencies of up to 60Hz.

In practical applications the common mode signal, – i.e. the voltage with respect to ground of the low side of the signal to be measured –, may present a finite impedance to the Common terminal of the 2608. At high frequencies the capacitance between the Common and Ground may allow current to flow in the common source impedance. The voltage developed across the common impedance will appear as a series signal at the input to the 2608 and be added to the signal to be measured.

The user should take steps to avoid the effects of this error voltage when taking measurements. The error voltage alone can be viewed by connecting both the input and the common of the probe to the low side of the signal measurement points. The resultant trace on the screen will show any non–rejected common mode signal.

2.7 Plot

A plot of the screen display can be obtained by pressing the Plot button (45). The plot can be sent to the internal 4 color plotter if it is fitted, or it can be sent to an external plotter via the RS423 or GPIB interface if fitted.

The plot destination and parameters are set via the menu system. See section 3.7

2.7.1 Internal Color Plotter

When using the internal color plotter background plotting is provided.

When the plot button is pressed, both the **Plot On** and **Hold All** on lamps light. After about 1 second the Hold All lamp goes out indicating that the plot data has been transferred to the plot buffer and that the instrument can be used again. The Plot On lamp will remain lit until the plot is complete when it will go out and the message 'PLOTTING COMPLETE' will briefly appear on the screen. Further presses of the Plot button during a plot are ignored.

If the Abort button (46) is pressed while the Plot lamp is on, the plot will be aborted. Any changes to the instrument status during a plot will have no effect on the plot as the data has already been transferred and stored in the plot buffer. If a calibration occurs during a plot, the plot slows down but there is no change to the stored data.

The plot buffer is also used by some functions on the waveform processor. This means that background plotting may not available during some waveform processor functions.

Color Plotter Paper

Selection The only recommended paper for use with the 104 color plotter is Gould plotter paper. Part No. 04101165 for a pack of eight rolls. Other paper may damage the mechanism.

Loading

CAUTION: When loading paper, extreme care should be taken not to force any of the plotter mechanism. NEVER pull paper through by hand, always use the paper advance button to prevent damage to the plotter mechanism.

1. With scissors, cut the end of the paper square.
2. Open the plotter cover by depressing the catch and lifting the cover until it is fully open.
3. Remove the shaft from the paper cradle and if the plotter has been used previously remove the cardboard tube from the shaft.
4. Insert the end of the paper into the slot in the bottom of the plotter feeding the paper from the underside of the roll as shown in figure 2.7.1 below.
5. Insert the shaft through the paper roll and fit the roll into the paper compartment.
6. Press the paper feed button (blue) until there is enough paper to pass the paper through the slot in the top cover.
7. Close the plotter cover and ensure that it latches shut.

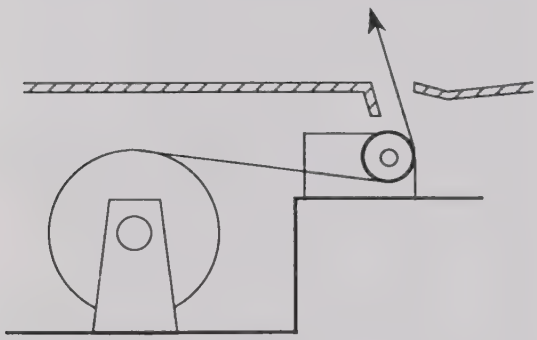


Figure 2.7.1 Color Plotter Paper Loading

Pen Installation and removal. Only Gould Pens should be used in the 104 color plotter. Part No. 04101175 for a pack of one of each color.

The normal pen sequence is:

Pen No.	Color
1	Black
2	Blue
3	Green
4	Red

The pen holder carriage is color coded for this sequence.

CAUTION: When changing a pen, extreme care should be taken not to damage any of the plotter mechanism. NEVER move the pen carriage by hand.

To change a pen, ensure that the instrument is switched on and then proceed as follows:

1. Select the plot menu and press the pen change button - **8** - once. See section 3.7. This rotates the pen carriage and moves the carriage to the right hand side of the plotter.
2. Gently press the white grooved eject lever towards the front of the instrument. The top pen will be ejected from the pen carriage and can be removed from the plotter.
3. Insert the tip of the new pen into the carriage guide hole. Gently snap the other end of the pen into place.
4. When the pen has been changed, press the paper feed button –blue- and the carriage will move back to the left hand side ready for the next plot.

3.0 The Menus

The 2600 series instruments have a menu system for selecting further features and modes of operation. The menu structure is summarized in figure 3. The numbers **0** to **9** refer to the numeric buttons (1) used to select the particular menus and menu items. All front panel controls remain live when menus are displayed, allowing the control status to be changed at any time.

The menus consist of rows of text each of which is in line with one of the numeric buttons. On some of the lines there are characters in inverse video, these show which option has been chosen. In some cases, when there are a large number of options, only the selected one is shown.

The inverse characters that are flashing signify that they are on the active line. The entry on this line can be changed by the relevant numeric button or by the horizontal datum paddle (5). This paddle is also useful for skipping over digits in numeric entry mode.

The vertical datum paddle (3) can be used instead of the numeric buttons to change the active line.

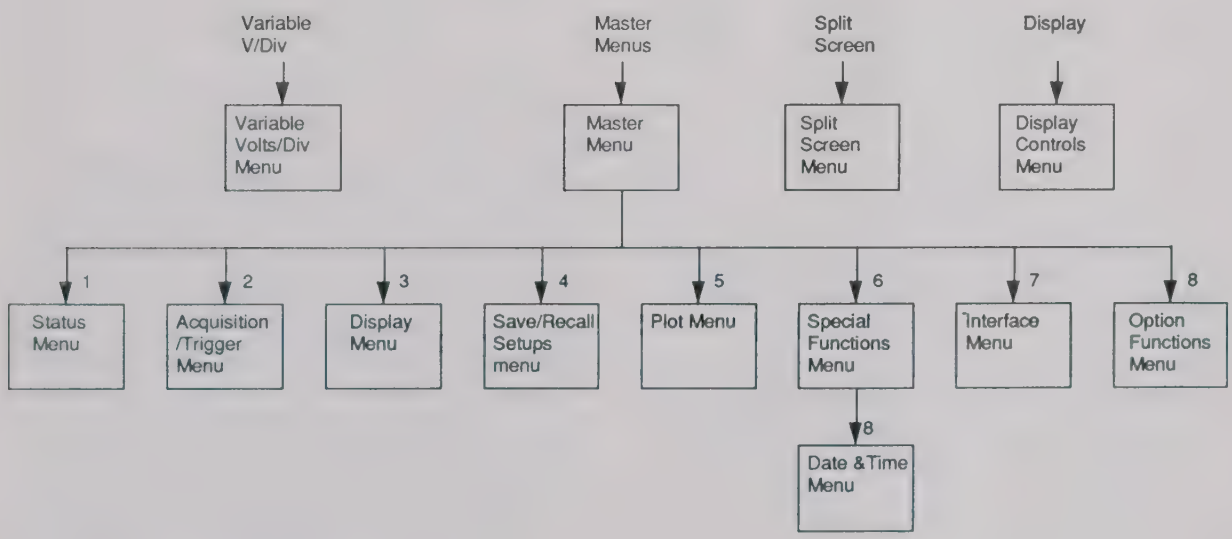


Figure 3. The Menu Structure

3.1 Menu Buttons

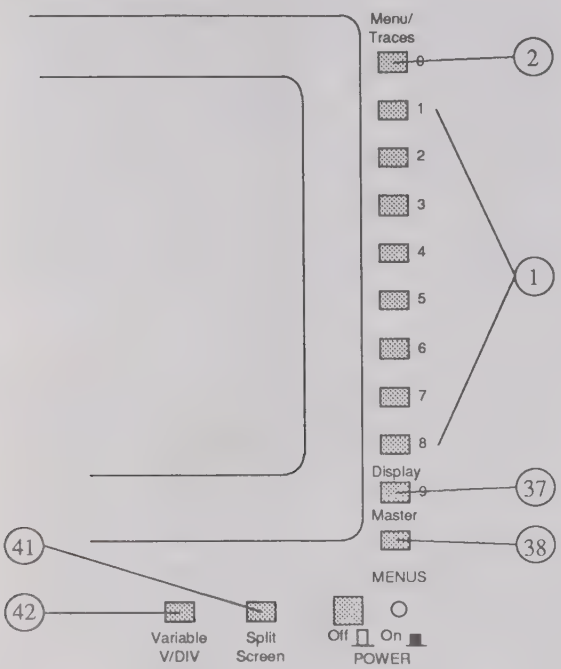


Figure 3.1 The Numeric Buttons

3.1.1 The numeric Buttons

The buttons 1 to 8 (1) are used when menus are displayed to operate or select various menu functions described in sections 3.2 to 3.12.

3.1.2 0: Menu/Traces

This button (2) toggles the display between the traces and the last used menu.

3.1.3 Master

This button (38) changes the current display, whatever it may be, to the Master Menu.

3.1.4 9: Display

Button (37) adds the Intensity Focus Menu to the trace display. This button only works when the traces are displayed. It has no effect when menus are displayed.

3.1.5 Variable V/Div

Button (42) adds the Variable Gain Menu to the trace display. This button only works when the traces are displayed. It has no effect when menus are displayed.

3.1.6 Split Screen

Button (41) adds the Split Screen Menu to the trace display. This button only works when the traces are displayed. It has no effect when menus are displayed.

3.2 Master Menu

Each entry on the master menu is also a menu, covering one set of functions. The text is lined up with the numeric buttons 1–8 on the side of the display. To obtain any secondary menu simply press the relevant button.

STATUS	1
ACQUISITION / TRIGGER	2
DISPLAY	3
SAVE/RECALL CONTROL SETTINGS . .	4
PLOT	5
SPECIAL FUNCTIONS	6
RS423 INTERFACE	7
OPTION FUNCTIONS	8

<< MASTER MENU >>

Figure 3.2 The Master Menu

The options available on the master menu are as follows:

STATUS Displays information about the present and stored set-ups of the instrument. See section 3.3.

ACQUISITION/TRIGGER Controls probe sensitivity, Glitch detect function dual trigger and trigger delay. See section 3.4.

DISPLAY Controls the Max-min function, X-Y mode, Dot join, and the saving and recalling of the trace memories. See section 3.5.

SAVE/RECALL CONTROL SETTINGS Saves and recalls the instrument set-ups to the 4 set-up memories. See section 3.6.

PLOT Sets the plot mode, plot device, and Graticule type and sets other parameters appropriate to the output device. See section 3.7.

SPECIAL FUNCTIONS Controls the mathematical trace manipulation, provides calibration control and gives access to the Date and Time Menu. See section 3.8.

RS423 INTERFACE or GPIB INTERFACE Sets the parameters for either the RS423 or GPIB interface. See section 3.9. This line is only shown if either a GPIB or RS423 interface is fitted to the back of the instrument.

OPTION FUNCTIONS Provides control for the optional waveform processor. See section 3.10. This line is only shown if waveform processor pod is fitted to the back of the instrument.

3.3 Status Menu

This menu allows the status of the various horizontal, vertical and trigger settings to be viewed but not altered. To change any settings, the relevant control or menu should be used. A typical display is shown in figure 3.3.

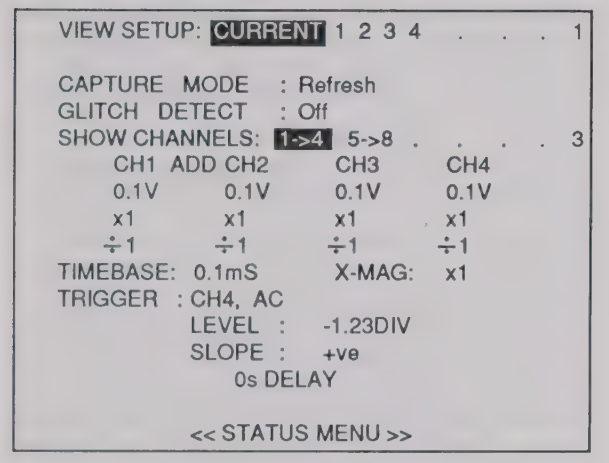

VIEW SETUP: CURRENT 1 2 3 4 . . . 1
CAPTURE MODE : Refresh
GLITCH DETECT : Off
SHOW CHANNELS: 1->4 5->8 3
CH1 ADD CH2 CH3 CH4
0.1V 0.1V 0.1V 0.1V
x1 x1 x1 x1
÷1 ÷1 ÷1 ÷1
TIMEBASE: 0.1mS X-MAG: x1
TRIGGER : CH4, AC
LEVEL : -1.23DIV
SLOPE : +ve
0s DELAY
<< STATUS MENU >>

Figure 3.3 A Status Menu

View Set-up Either the current or one of the four stored set-ups or statuses can be viewed. They are selected by pressing soft key **1** until the required selection is highlighted.

Capture Mode There are three possible capture modes: Refresh, Roll or X-Y

Glitch Detect This entry shows the state of the Glitch Detect function. One of the four possible states will be shown; Off, Max only, Min only, or Max & Min.

Show channels There is not enough space on the display to show the vertical sensitivity and probe ratio for all eight channels simultaneously so either channels 1 to 4 or 5 to 8 can be selected by pressing soft key **3**.

The channel entries show in their first line the input sensitivities in volts per division in the range 10mV to 5V. If add mode is selected, 'ADD' is shown between the appropriate channels. Along with the sensitivities of the channels, other information is also shown using the following symbols:

—	Trace inverted
⏚	Ground
>	Uncalibrated
~	AC Coupled
ADD	Channels Added

After the sensitivities, the next line of information shows the probe gain settings which can be x1, x10, x100 or x1000. These are set using the Acquisition/Trigger menu. See section 3.4. Below this the trace compression ratios used for split screen mode are shown. See section 3.14.

Timebase The sweep rate of the timebase is shown in s, ms, µs or ns per division.

X-Mag The X magnification factor is shown. If X-Mag is turned off, the display shows x1

Trigger This section shows the selected trigger parameters. The choices of source are CH1 to CH8, Ext and Line. If Dual trigger is active, then both the channel numbers will be shown against the trigger source entry.

The available couplings are AC, DC, AC hf rej and DC hf rej. The trigger level is shown in terms of the number of screen divisions above the bottom of the graticule. The trigger slope will be either +ve (rising slope) or –ve (falling slope).

The last piece of information about the trigger set-up is the delay setting. This is given in s, ms, µs, ns, events or clocks as appropriate. For pre–trigger operation, the figure is given as a percentage; 0% when the trigger point is at the left–hand edge of the display and 100% at the right–hand edge.

3.4 Acquisition / Trigger Menu

This menu allows the probe ratio for each channel to be set, the glitch detect function to be turned on and off and the delay trigger parameters to be set.

Figure 3.4a The Acquisition Trigger Menu with delay by time

Probe Ratio. An independent probe attenuation can be set for each of the input channels. The channel is selected with successive presses of button **1** and the ratio set for the selected channel with successive presses of button **2.** The ratios available are x1, x10, x100 and x1000. Having selected a ratio, the Volts per division is scaled by that factor and the 'V' on the display is shown in inverse video to signify that a ratio other than one is in use. If this ratio is used with an appropriate probe, the sensitivities shown will be correct.

Glitch Detect. Using button **3** the glitch detect function can be controlled.

Glitches are detected by a Max–Min capture system which is designed to detect narrow glitches that may occur between samples. It operates on the signal before it is placed in the acquisition store and can detect narrow pulses down to 50ns wide. Any glitches detected will at least be displayed as a spike.

There is a similar feature, Display Max–Min, which allows events in the acquisition store to be displayed even if they occur between the display sample points. See section 3.5.

When Max is selected, the instrument samples the signal at the maximum sample rate regardless of the timebase setting and remembers the maximum level seen. At the appropriate time this maximum level is placed into the acquisition store so that the maximum signal levels are stored even if they occur between the normal sample times for the timebase selected.

The Min detect mode works in the same way except that the minimum levels are stored.

When Max-Min is selected both the maximum and minimum detections are performed simultaneously and both levels are remembered for a period equal to two samples. These levels are then alternatively placed in the acquisition store in the same order in which they occurred. i.e. if a minimum level is seen before a maximum level then the minimum level will be transferred to the acquisition store at the first sample time and the maximum level at the second sample time.

Max-Min is useful for detecting aliases because if there are many Maximum and minimum points these levels will be alternately stored so building up an envelope of the waveform. If the signal peak-to-peak amplitude is constant then the envelope will appear as two horizontal lines.

Using the glitch detect feature it is possible to capture a single sample peak in the acquisition store. This would not necessarily be seen on the display, so the instrument automatically turns Display Max-Min On when glitch detect is selected. See section 3.5.

Dual Trigger. Button **4** turns the Dual Trigger function On and Off.

The Dual trigger function provides a limited ORing of trigger signals from two channels, one channel must be even numbered and one odd numbered. Assuming that the instrument has been set to positive triggering, if either of the signals rise through the trigger level a trigger will be generated. See section 2.1.2 for further details.

Pretrig No Delay Delay. See also section 2.2. Button **5** selects the trigger delay required, either Pre trigger, delay trigger or no delay.

When No Delay is selected, there is no further information displayed on this menu.

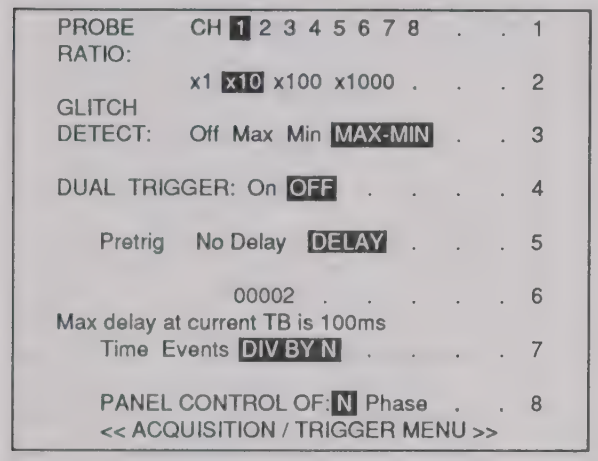

PROBE CH 1 2 3 4 5 6 7 8 . . 1
RATIO:
x1 x10 x100 x1000 . . . 2
GLITCH
DETECT: Off Max Min MAX-MIN . . 3
DUAL TRIGGER: On OFF 4
Pretrig No Delay DELAY . . . 5
00002 6
Max delay at current TB is 100ms
Time Events DIV BY N 7
PANEL CONTROL OF: N Phase . . 8
<< ACQUISITION / TRIGGER MENU >>

Figure 3.4b The Acquisition Trigger Menu with delay divided by N

If Pre Trigger is selected, the percentage is shown alongside button **6**. This value can be entered by typing in a value using the numeric buttons and can be edited by selecting the required digit using the horizontal datum cursor paddle and then typing the new value again using the numeric buttons. To leave the entry field either use the vertical datum cursor paddle to change to the line above or below, or type in digits until the end of the field is reached.

If Delay is selected, a further three choices are shown along side button **7**. These three choices, Time, Events and Div by N, refer to the three modes of delay trigger as described in sections 2.2.2 to 2.2.4.

To select one of the choices press button **7**. For each of the choices different information is presented alongside buttons **6** and **8**. The numerical value at button **6** can be entered in the same way as pretrigger above.

Delay values entered in this menu can be altered during normal operation of the oscilloscope by using the trigger delay paddle (23).

3.5 Display Menu

This menu allows various display features to be turned on and off and also controls the trace memories.

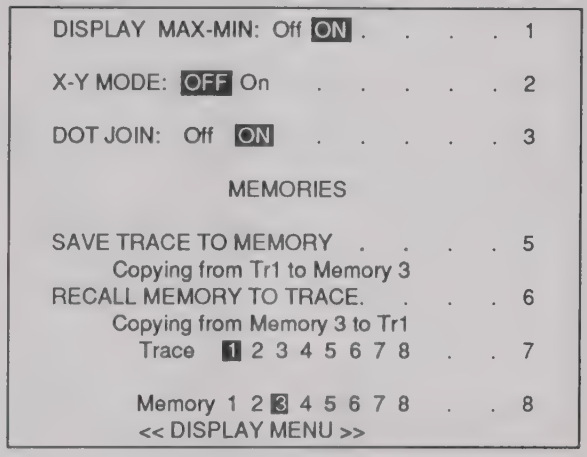

DISPLAY MAX-MIN: Off ON 1
X-Y MODE: OFF On 2
DOT JOIN: Off ON 3
MEMORIES
SAVE TRACE TO MEMORY 5
Copying from Tr1 to Memory 3
RECALL MEMORY TO TRACE. . . . 6
Copying from Memory 3 to Tr1
Trace 1 2 3 4 5 6 7 8 . . 7
Memory 1 2 3 4 5 6 7 8 . . 8
<< DISPLAY MENU >>

Figure 3.5 The Display Menu

Display Max-Min: When this mode is OFF and X-MAG is off, every 10th point from the acquisition store is displayed. When this feature is turned on however, the display will show the maximum and or minimum points in the same way as the glitch detect feature, so that single events falling between every 10th sample point can be seen. Display Max–Min is forced On if Glitch detect is On .

X-Y Mode: This mode provides an X-Y display of the data captured by the timebase and trigger systems. When X-Y is turned on by pressing button **2** the X (horizontal) component of the display is provided by CH1 input and the Y (vertical) components by the other inputs. The timebase should be set slow enough to capture all of the signal of interest. This mode is not available with X-Mag. The sample rate is 1000th of the display timebase setting.

If X-Y is selected when trace compression has been set for channel 1, the compression will be turned off since channel 1 becomes the horizontal instead of the vertical component of the display. It is perfectly valid for channels 2 to 8 to have a compression ratio applied to them. When X-Y is subsequently turned off, channel 1 will revert to its previously compressed state.

Dot Join: Button **3** selects the dot joining function. On some X-Magnified or high speed traces, gaps can be visible between the sample points, and in some cases this prevents the overall picture being visualized correctly. If the dot joining feature is **Off** the sample points alone will be displayed but if **On** is selected the data will automatically be joined by straight lines thus completing the displayed picture.

Memories: There are eight non volatile 1K display trace memories, each of which can store a displayed trace. Any held trace can be copied to any memory and any memory can be recalled to any trace.

To save or recall a trace, set up the source and destination using buttons **7** and **8** and then press either button **5** or **6** as appropriate. A message will appear to confirm the action.

A trace saved to a memory will overwrite any previously stored data in that memory. Similarly a memory recalled to a trace will overwrite the existing trace. Recalling a memory to a trace forces that trace to be turned on and held, thus preventing the recalled data from being overwritten almost immediately by a fresh acquisition.

3.6 Save/Recall Control Settings Menu

This menu allows up to 4 instrument set-ups to be saved and recalled. The set-up includes all the front panel control status, the trigger status and any other parameters set up in the menus.

Save setup	to	Memory 1 . .	1
	to	Memory 2 . .	2
	to	Memory 3 . .	3
	to	Memory 4 . .	4
Recall setup	from	Memory 1 . .	5
	from	Memory 2 . .	6
	from	Memory 3 . .	7
	from	Memory 4 . .	8

<<SAVE & RECALL SETTINGS MENU>>

Figure 3.6 The Save and Recall Settings Menu

Save setup: To save the current instrument set-up to a memory press button **1, 2, 3** or **4**. The set-up is then saved to the chosen memory, overwriting any previously stored data in the same memory.

Recall setup: To recall a stored set-up, press button **5, 6, 7** or **8** as required. A message then appears asking you to press the same button again to recall the set-up. If the same button is pressed a second time, the selected instrument set-up is recalled and replaces the current instrument status. Pressing any other button or control, when asked to press a second time, prevents the set-up being recalled.

3.7 Plot Menu

This menu is only available if a plotter of interface pod if fitted to the instrument. It allows various parameters of the plot to be set.

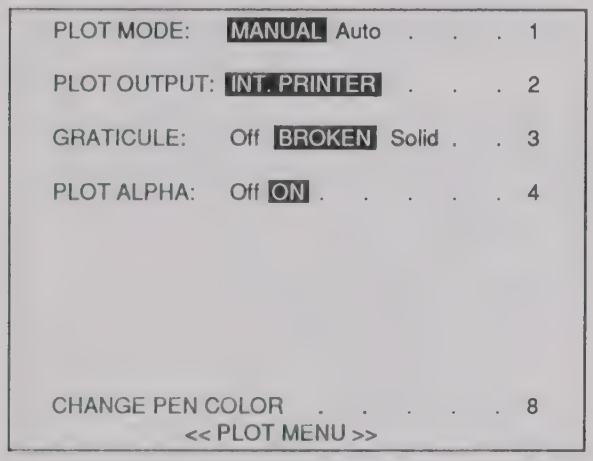


Figure 3.7 Plot Menu

There are 3 possible plot types set from this menu. They are plots to an internal color plotter and plots to an external plotter via either a RS423 or a GPIB interface.

Many of the features set on this menu are common to each of the plotter types and they are discussed below. Features unique to individual plotter types are described under the appropriate headings.

When plots are requested, the screen data is transferred to the plotter's data buffer. During the data transfer the instrument is held and the front panel controls are inoperative. When the data has been transferred the instrument is released. The data transfer typically takes about 1 second.

Plots contain a complete copy of the instrument's display including the datum lines and measurement cursor if they are turned on. The position of the trace relative to the graticule on the plot may not correspond exactly with the trace/graticule alignment on the screen because there is no signal connection between the display and the screen graticule.

Plot Mode:

Manual Plot: If manual mode is selected, each time the plot button (45) is pressed a plot of the current screen display will be initiated. Pressing the abort button (46) will abort the plot.

Auto Plot: In Auto mode the plot sequence is started by pressing the plot button (45). A plot is initiated immediately and once the display data has been transferred to the plot buffer and the plot completed, the instrument rearms and waits for the next trigger, when it will again acquire the input signals. When this acquisition is complete another plot is initiated.

This process will repeat until the abort button (46) is pressed.

Plot Output: Selection 2 contains hidden options that toggle around with successive key presses as shown below and allows the required plot destination to be selected.

PLOT OUTPUT: INT PLOTTER

RS423 or GPIB (if fitted)

Int Plotter: Choose this option if an internal color plotter is fitted and is required to be the plot destination.

RS423: This item should be selected if the required plot destination is an external plotter connected via the RS423 interface. The plotter must be connected to interface slot 1 – the top connector – on the RS423 interface pod fitted to the rear of the instrument.

Typical connection diagrams for RS423 interfacing cables are shown below in figure 3.7c. The 2600 to Gould 6120 cable may be ordered from service centers and distributors, part number 04091197.

The 2600 communicates with an external plotter using HPGL.

2600 25 way male plug	Gould 6120 25 way female socket
1	1
2	2
3	3
5	20
7	7

2600 25 way male plug	HP 7475 25 way male plug
1	1
2	2
3	3
5	20
7	7

Figure 3.7c RS423 Interface cables

GPIB: This item should be selected if the required plot destination is an external plotter connected via the GPIB interface.

The plotter must be set to be in listen only mode.

In order to function correctly all the address switches on an HP7475 plotter must be switched to 1.

The 2600 communicates with an external plotter using HPGL.

Graticule: The graticule can either be plotted as solid or dotted lines or it can be omitted from the plots by selecting the required option using button **3**.

Plot Alpha: All the alphanumerics that can appear on the plots can be included or omitted depending on the highlighted option selected with button **4**

The trace identifying text is always present regardless of the state of this option.

If the alphanumerics are turned on, all the on screen labeling including GPIB entries, cursors and waveform processing measurements are reproduced on the plots. The trace labeling is not user programmable.

Color Plotter

When a color plotter is fitted to the instrument an extra line appears on the plot menu alongside button **8**;

CHANGE PEN COLOR 8

Pressing this button causes the pen carriage to rotate one position. This is useful when changing pens. See section 2.7.

3.8 Special Functions Menu

This menu allows simple arithmetic to be applied to the displayed traces and also controls the auto calibration function. The Date and Time menu is accessed through this menu.

Trace **1** 2 3 4 5 6 7 8 . . . 1

ADD Subtract Multiply . . 2

Trace 1 **2** 3 4 5 6 7 8 . . . 3

RESULT:

To Trace 1 2 **3** 4 5 6 7 8 . . . 4

CALCULATE 5

CH1 + CH2 to CH3

AUTOCAL: **DISABLE** Enable . . . 6

FORCE RE-CALIBRATION 7

(Trig. phase will be lost)

SET DATE AND TIME. 8

<< SPECIAL FUNCTIONS MENU >>

Figure 3.8 The Special Functions Menu

Add Subtract Multiply: Any of the displayed traces can be added to, subtracted from or multiplied by any displayed trace including itself.

Buttons **1**, **2** and **3** select the traces involved and the calculation required, with the selected options being highlighted.

The voltage datum line is used as the reference point for all three calculations. Because multiplied traces can easily become larger than the display, the trace multiplication result is scaled by a factor of 0.2 – i.e. the result is divided by 5.

Result: The result of the calculation will be stored in the highlighted trace selected with button **4**. The selected trace is automatically turned on and held to prevent the resultant trace being overwritten almost immediately by a fresh acquisition.

Calculate: Pressing button **5** causes the calculation to happen. When button **5** is pressed the calculation performed is described between lines 5 and 6 of this menu.

Autocal: The automatic calibration procedure balances any offsets and removes any gain errors in each individual channels amplifiers. The instrument's auto calibration procedure can be enabled or disabled as required by pressing button **6**. The selected option is highlighted.

If autocal is enabled, an autocal occurs 30 minutes after power up. Further calibrations occur every half hour if the instruments internal temperature has changed by more than a preset limit. These half hourly calibrations are only performed on channels and ranges that are active at that time.

As long as autocal is enabled, when a channel is turned on, or a range is changed on an active channel and the temperature has changed by more than a preset limit, then after a 2 second delay that particular channel range will be calibrated.

Each calibration takes about 1 second. If the occasional interruption of the normal operation of the instrument is unacceptable to the user, the autocal facility can be turned off. A Forced Recalibration is then recommended 30 minutes after switch on from cold and additionally if there is a significant change in the ambient operating temperature.

Force Recalibration: Button **7** causes the instrument to perform a complete recalibration of all channels and ranges. To obtain the best results from this function the instrument should have operating for at least half an hour.

Note: No channel calibrations will be performed if the instrument is armed waiting for a trigger, in a data capture cycle, or in continuous roll mode, they will simply be postponed until these conditions end. Force recalibration is always available.

Set Date and Time: Pressing button **8** changes the menu display to the date and time menu where both the date and time can be checked and if required altered. See section 3.9

3.9 Date and Time Menu

This menu allows the user to set the Date and Time of the internal battery backed up clock.

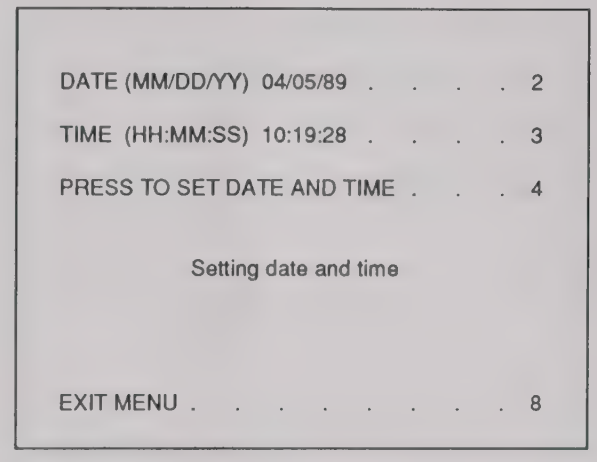


Figure 3.9 The Date and Time Menu

To set the date press button **2**. The first field of the date will then flash to indicate numeric entry mode. Using the numeric keys enter the required number. The field will automatically change to the next one when two digits have been entered. To jump to the next field use the horizontal datum paddle (5).

To set the time press button **3**. The first field of the time will then flash to indicate numeric entry mode. Using the numeric keys enter the required number. The field will automatically change to the next one when two digits have been entered. To jump to the next field use the horizontal datum paddle (5).

Press button **4** to action any changes to the date or time, and set the new values in the instrument. If button 4 is not pressed, the date and time will not be changed.

Pressing button **8** changes the display back to the Special Functions menu. If button 4 has not been pressed, the date and time will not have been changed.

Note: While this menu is displayed, the date and time displays are not updated although the internal clock is maintained.

3.10 RS423 or GPIB Interface Menu

This menu allows either the RS423 or GPIB communication parameters to be set up depending upon which, if any function pod is fitted to the instrument. The GPIB menu only contains one item.

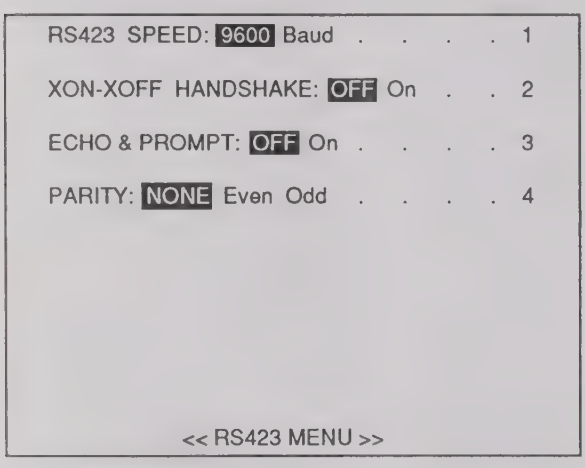


Figure 3.10a The RS423 Menu

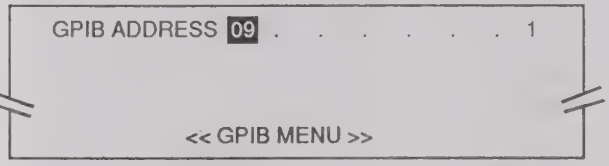


Figure 3.10b The GPIB Menu

RS423 Interface

Data communication is always with one start bit, eight data bits and one stop bit. Other data parameters can be set using buttons **1** to **4**.

RS423 Speed: With this item the I/O baud rate can be set using button **1**. The data rate can be set to 75, 150, 300, 600, 1200, 2400, 4800 or 9600 baud.

XON–XOFF Handshake: Button **2** is used to turn the XON–XOFF (software) handshaking On and Off.

Echo & Prompt: Button **3** is used to turn the echo & prompt option On and Off. If this option is turned On, all characters sent to the oscilloscope will be echoed back to the transmitting device and when the 2600 is ready to receive the next command, it will issue a prompt.

Parity: The parity can be set to None, Odd or Even by successive presses of button **4**.

GPIB Interface

GPIB Address: The GPIB address can be set to any number from 1 to 32 by pressing button **1**.

3.11 Option Functions Menu

This menu allows the waveform processor memory module option 2600/205, if fitted, to be used.

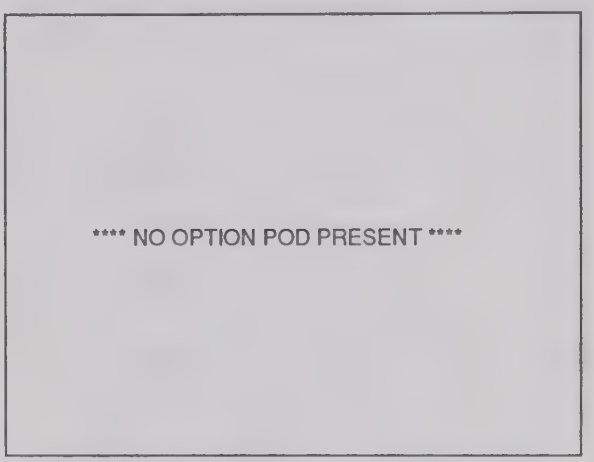


Figure 3.11 The Option Functions Menu (No Memory Module)

When a memory module is not fitted, pressing button **8** from the Master Menu produces the message shown in figure 3.11.

If a memory module is fitted, the menu changes to allow control of the memories. For details the menu and its memory management operations see figure 5.4.13 and section 5.4.

3.12 Display Controls Menu

This menu allows the intensity of the traces, the intensity of the alphanumerics, the display focus and the trace rotation to be independently varied.

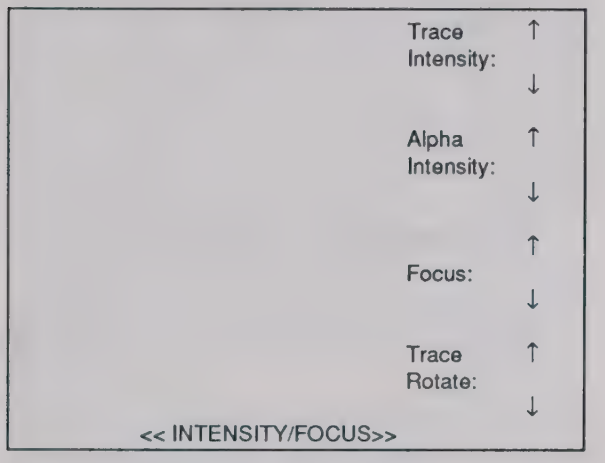


Figure 3.12 The Display Controls Menu

Trace Intensity: Button **1** increases and button **2** decreases the intensity of all the displayed traces.

Alpha Intensity: Button **3** increases and button **4** decreases the intensity of all the alphanumerics on the display.

Focus: The focus of both the traces and alpha numerics can be varied by pressing buttons **5** or **6**.

Trace Rotate: The traces and the alpha numerics can be rotated relative to the graticule. Button **7** rotates them clockwise and button **8** rotates them anti–clockwise.

The trace may need to be rotated because the alignment of the CRT trace is a function of the earth's magnetic field. The alignment will change if the location of the instrument is changed, and will even vary slightly with a 90° change in the orientation of the instrument.

3.13 Variable V/Div Menu

This menu allows each input channel's sensitivity to be either calibrated or continuously variable.

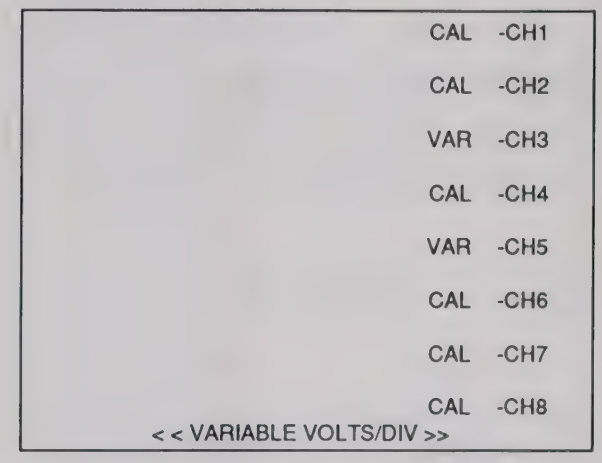


Figure 3.13 The Variable V/Div Menu

Pressing any of the buttons **1** to **8** toggles that particular channel between a calibrated and uncalibrated state. The display changes from CAL to UNCAL to reflect this. In the uncal state that channels V/Div paddle acts as a continuously variable gain control, varying the gain from x1 to x0.4 of the V/Div that was selected when the channel was switched to uncal.

When a channel is in uncal state, a > sign is placed in front of the V/div readout on the display, and the relevant front panel indicator (29) is illuminated.

3.14 Split Screen Menu

This menu allows the split screen display mode to be controlled.

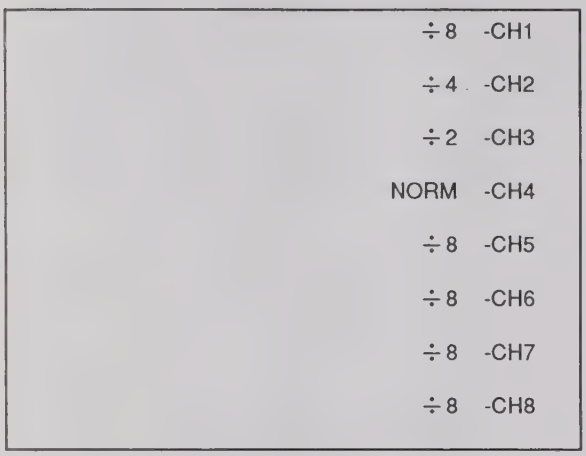


Figure 3.14 The Split Screen Menu

This mode allows traces to be compressed for display purposes yet retain their full captured resolution. This means that eight traces can be captured at full screen height, and subsequently compressed. This enables the individual traces to be easily located and identified, yet retains the best possible accuracy of the on screen cursor measurements.

Compression factors of normal 2, 4 and 8 are available for each channel. Individual channels can be independently set to any of the factors.

To set any channel press the numeric button corresponding to the channel . Each press of the button steps through the compression options in the following order: ÷2, ÷4, ÷8, NORM, ÷2 etc. The selected option is shown alongside the channel number.

Compressed traces are confined to particular parts, or windows, on the display as detailed below.

÷2 Channels 1, 2, 3 & 4 are limited to the top four divisions. Channels 5, 6, 7 & 8 are limited to the bottom four divisions.

÷ 4 Channels 1 & 2 are limited to the top 2 divisions. Channels 3 & 4 are limited to the next 2 divisions. Channels 5 & 6 are limited to the next 2 divisions. Channels 7 & 8 are limited to the bottom 2 divisions.

÷8 Each channels is limited to one division. Channel 1 to the top division through to channel 8 in the bottom division.

Since it is possible to independently set the compression factor for each channel, compressed traces at different factors may overlap each other on the display.

When a channel is in split screen mode, a ÷ symbol is placed in front of the V/div value at the top of the screen. If Uncal is also on for a particular channel, the ÷ symbol replaces the > sign. The Uncal status is still indicated by the Uncal light (29).

4. Performance Checking

The aim of this section is to allow the user of a 2600 to verify the major analog performance parameters. Should any of these fail to be within specification, then it is recommended that the instrument be re–calibrated. A skilled technician with the aid of the service manual will be able to perform this task; alternatively return the instrument to your local Gould distributor.

The best method of connecting test signals to the 2608 is through a standard 50Ω BNC coaxial cable terminated if required and connected to a BNC to Lemo convertor at the scope input.

If BNC to Lemo convertors are not available, the instrument's probes can be used by switching them to x1 and using the probe to BNC adaptor. If this method is used allowance should be made for the absence of a 50Ω termination.

4.1 Bandwidth

Equipment Required:

Leveled signal generator: Tektronix SG503 or similar;
50 Ohm coaxial cable;
50 Ohm terminator;
BNC to Lemo convertor.

Connect the signal generator to a channel input through the coax cable, the terminator – which should be at the 2600 end of the cable – and convertor.

1. Select 10mV per division on the input channel and set the timebase to 50µs per division.
2. Set the amplitude of the signal generator to give six divisions at 50kHz or similar reference frequency.
3. Increase the frequency of the signal generator until the peak to peak amplitude reduces to 4.2 divisions.

The measured frequency should be greater than 7Mz.

4.2 Trigger sensitivity

Equipment Required:

Signal generator: Tektronix SG503 or similar;
50 Ohm coaxial cable;
50 Ohm Terminator;
BNC to Lemo convertor.

Connect the signal generator to a channel input through the coax cable, the terminator – which should be at the 2600 end of the cable – and convertor.

1. Select 100mV per division on the input channel and set the timebase to 50µs per division.
2. Select **Auto** trigger.
3. Set the signal generator to 50kHz or similar reference frequency and adjust the amplitude to give 3mm peak to peak.
4. Select **AC** coupling and **Norm** on the trigger controls.

It should now be possible to find a suitable trigger level to obtain a stable picture.

4.3 Trigger Bandwidth

Equipment Required:

Leveled signal generator: Tektronix SG503 or similar.
50 Ohm coaxial cable;
50 Ohm terminator;
BNC to Lemo convertor.

Connect the signal generator to a channel input through the coax cable, the terminator – which should be at the 2600 end of the cable – and convertor.

1. Select 100mV per division on the input channel and set the timebase to 50µs per division.
2. Set the amplitude of the signal generator to give six divisions at 50kHz or similar reference frequency.
3. Select **AC** coupling and **Norm** on the trigger controls.
4. Without adjusting its amplitude, set the signal generator to 7MHz

It should be possible to adjust the trigger level to give a stable trace.

4.4 Timebase Calibration

Equipment required:

Time calibrator: Bradley oscilloscope calibrator type 192 , Tektronix TG501 or similar;
50 Ohm coaxial cable;
50 Ohm terminator;
BNC to Lemo convertor.

Connect the signal generator to a channel input through the coax cable, the terminator – which should be at the 2600 end of the cable – and convertor.

1. Set the calibrator to produce markers every 50µs.
2. Set the timebase to 50µs per division and set the channel attenuator to give between two and five vertical divisions of signal.
2. Set **DC** coupling and **Norm** on the trigger controls.
3. Adjust the trigger level to give a stable trace.
4. Select the cursors.

With the time datum and the cursor on identical positions on any two different markers, the time difference should read in multiples of 50µs to within 0.1%.

Note: *Failure of this specification point is indicative of a major system fault and the instrument should be serviced immediately.*

4.5 Vertical Calibration

Equipment required:

Oscilloscope calibrator: Bradley type 192 or similar;
Coaxial cable;
BNC to Lemo convertor.

Connect the vertical calibration output of the oscilloscope calibrator to the 2600 through the coax cable and convertor.

1. Set the timebase to 500µs per division and select 10mV per division for the input channel.
2. Set the calibrator to give 50mV peak to peak, i.e. 5 screen divisions.
3. Adjust the trigger level to give a stable picture.
4. Switch the cursors on.

The peak to peak measurement should be 50mV to within ±3% and the trace should be 5 divisions high to within ±0.1 divisions.

These measurements should be repeated on all the attenuator ranges, each time setting the calibrator to 5 screen divisions for the selected range.

4.6 Glitch Detect (Alias Detection)

Equipment required:

Signal generator: Tektronix SG503 or similar;
50 Ohm coaxial cable;
50 Ohm terminator;
BNC to Lemo convertor.

Connect the signal generator to a channel input through the coax cable, the terminator – which should be at the 2600 end of the cable – and convertor.

1. Set the timebase to 100µs per division and select 100mV per division on the input channel.
2. Set the generator to give approximately 5 divisions at 10kHz and adjust the trigger level to give a stable trace.
3. Select 10ms per division on the timebase. You should notice that the screen picture will change considerably with small changes in input frequency.
4. Carefully adjust the frequency of the signal generator to produce a sine wave of approximately 2 to 5 cycles. This is an alias.
5. Turn on the MAXMIN glitch detect function in the Acquisition/Trigger Menu.

If the glitch detect is functioning correctly, then two roughly horizontal lines should be displayed. These will be at the maximum and minimum peak levels of the signal.

5.0 INTERFACE OPTIONS

There are three interface options available for the 2608:

An RS423 interface pod; option 102A, a GPIB interface pod; option 103A and a waveform processor and memory module pod; option 260 and 205.

Each of the pods fits to the rear panel of the instrument. Only one can be fitted at any one time. Once fitted, the pod's features can be controlled through the menu system on the 2608.

5.1 Plotters/Output Devices

Various plotters can be controlled by the 2608 to provide permanent records of acquired traces and instrument set-ups. An internal four color plotter is available and external plotters can be connected to either the RS423 or GPIB interface pods.

5.1.1 Color Plotter

The internal color plotter for the 2608 is a factory fitted option and is located in the 2608's top cover. It only adds 2.5mm to the overall height of the instrument. Its operation is detailed in sections 2.7.1 and 3.7 of this manual.

5.1.2 RS423 and GPIB Plotting

Plots can be sent to an external plotter via either the RS423 serial bus or the GPIB parallel bus. Details of cable requirements for RS423 interfacing and instructions for plotting to an external plotter are given in section 3.7.

Both interfaces communicate with plotters using the standard HPGL command set.

5.2 Communication via GPIB/RS423

Both the GPIB and the RS423 interface options are very versatile allowing fast communication between a host computer and the 2608. The options are mutually exclusive, i.e. only one can be used at any one time.

The two ports are electrically different, but the communication format is essentially the same in either case. The main differences arise in the method of terminating a message or data block transmitted see 'Blocks' below.

Except where indicated this section applies to both GPIB and RS423 operation.

GPIB (IEEE–488)

This is a parallel bus interface allowing communication between a host computer and up to 30 peripherals. It is based on the controller/talker/listener structure whereby the controller – usually the host computer – commands various peripherals to 'talk' or 'listen' according to the desired data path. Each peripheral on the bus is assigned a unique address number and on the 2608 this is set via the GPIB interface menu –section 3.10.

There are three main modes of operation of the GPIB:

Local: The operator has full control of the instrument via the front panel. The 2608 may be interrogated but not manipulated in any way by the host computer.

Remote: All the 2608 GPIB commands can be used in this mode. The only front panel control that operates in this mode is the abort button (47) which when pressed, returns the instrument to local mode.

Local Lock Out: This is an extension of the Remote mode. None of the instrument's front panel controls operate.

The connections to the GPIB are listed below. For further details of the connector see Appendix 6.

Pin	Signal	Description	
1	DIO1	Data input output line 1	
2	DIO2	Data input output line 2	
3	DIO3	Data input output line 3	
4	DIO4	Data input output line 4	
13	DIO5	Data input output line 5	
14	DIO6	Data input output line 6	
15	DIO7	Data input output line 7	
16	DIO8	Data input output line 8	
5	EOI	End Or Identify	Interface Management Lines
17	REN	Remote Enable	
9	IFC	Interface Clear	
10	SRQ	Service Request	
11	ATN	Attention	
6	DAV	Data Valid	Handshake Lines
7	NRFD	Not ready for data	
8	NDAC	Data not accepted	
18	(DAV)		Return lines Twisted With same name line
19	(NRFD)		
20	(NDAC)		
21	(IFC)		
22	(SRQ)		
23	(ATN)		
12	Shield		
24	Logic Ground		

Table 5.2a GPIB IEEE–488 pin connections

RS423

The RS423 interface is an updated form of the RS232 standard and is a serial connection requiring a dedicated input and output on the host computer to each peripheral.

RS423 uses lower voltages and lower impedances than RS232 but is electrically compatible

Occasionally problems can be encountered with RS423 cabling. These difficulties are almost always resolved by correct connection of the data and handshake line to ensure the correct direction of signal travel.

The RS423 connections on the interface for the 2608 are listed below. For further details of the connectors see Appendix 6.

Interface 1 (Plotter)			Interface 2 (Bi–Directional Control)
Pin	Signal	Description	Pin
1	0V	Protective Ground	1
2	RXD	Receive Data	3
3	TXD	Transmit Data	2
4	RTS	Request to Send	4
5	CTS	Clear to Send	5
6	DSR	Data Set Ready	6
7	0V	Signal Ground	7
8	DCD	Data Carrier Detect	8
9	True	RS423 Logic True	9
14	True	RS423 Logic True	14
20	DTR	Data Terminal Ready	20

Table 5.2b RS423 Pin Connections

GPIB and RS423 Commands

The commands of the 2608 are simple and English–like. Where necessary, mnemonics have been used to replace large words or text. To enable the user to send more readable commands, spaces may be inserted freely within the commands. All spaces will be ignored except within the TXT command.

In this manual the following conventions and abbreviations are used:

<cr>	is used to represent the carriage return control code.
<lf>	is used to represent the line feed control code.
[ ]	denotes one of a set of options.
EOI	stands for: End Or Identify. (GPIB signal line).
A	Assertive command
D	Direct action command
I	Interrogative command
' '	denotes a reply by the instrument to an interrogative command.
number	means that a number is taken as the argument of the command.
*	Either the whole set i.e. all channels, or can be replaced by a single member of the set e.g. VP1.

Strings

A string is the smallest complete message that can be sent over the bus.

e.g. "HSA=5E-3"

Commas may be used as separators within a string and semi–colons can be used to separate strings from each other.

e.g. "HSA=5E-3;ST1=1,2,3..."

A string may only contain ASCII characters, except binary blocks. The space, character codes above 127 (decimal) and control codes other than line feed will be ignored.

Numbers

Numbers that appear in commands must conform to certain conditions:

- The number must contain less than 20 characters,
- The mantissa must be an integer, i.e. it must not contain a decimal point,
- The mantissa may contain a sign (+/–), + will be assumed if none is specified,
- The exponent is optional, if included it must be preceded by an 'E',
- The exponent may contain a sign, if omitted + is assumed.

Numbers transmitted by the 2608 will, in addition to the above constraints, use engineering notation such that the mantissa will contain less than four digits and the exponent if any will be a multiple of 3.

Blocks

A block is a collection of strings associated with bulk transfers. They are used to break bulk transmissions into smaller pieces which can be contained by the buffer in the 2608's bus controller. Blocks are separated and or terminated as listed below.

The RS423 port accepts <cr> and <lf> as terminators.

RS423 Separators between blocks

- <cr><lf>
- <lf>

RS423 Final block terminators

- <cr><lf>
- <lf>

The GPIB port accepts <cr> and <lf> as terminators. In addition the dedicated EOI bus line may be used. This line can be asserted with the final character of a transfer to signify the end of transmission (as opposed to the end of a block). i.e. if EOI is asserted, it is taken to indicate the final block. The use of EOI is optional, the command EOI is used to enable or disable this bus line. The GPIB default to EOI=ON.

GPIB Separators between blocks

- <cr><lf>
- <lf> without EOI asserted.

GPIB Final block terminators

- <cr><lf> EOI is asserted with <lf>, EOI enabled.
- <lf> with EOI asserted if EOI has been enabled.
- <lf> without EOI asserted if EOI disabled.
- Assert EOI with the last character set.

Records

A records is a group of one or more command strings separated by semi–colons and terminated as listed above.

The simplest form of a record has a singie string and is terminated by a <lf> with EOI.

e.g. "HSA=5E-3<lf>" EOI asserted with <lf>

The 2608 will accept and buffer characters from the bus until a correctly terminated record is completed or until the buffer overflows. Each command string in turn will be actioned before characters are accepted again.

Command Types

There are three types of command:

Interrogative: This is a request for the current setting of a control or the current contents of a memory to be transmitted. The instrument responds by sending an appropriate record. e.g sending "NB" will result in a record of the form "NB=BIN" being sent back.

Assertive: This requests that a setting or the contents of a memory be changed. Assertive commands are always in the form 'parameter=setting'. e.g "NB=DEC" will set the number base to decimal.

Note: Assertive commands are only valid when the instrument is in Remote mode. If an assertive command is received when the instrument is in local, a service request is generated.

Direct Action Assertive: These are commands which have a direct action rather than changing a setting. Generally they have no =in the string they are however constrained to remote mode as are the standard assertives. e.g. "ARM"

Service requests

Service requests are generated by the 2608 to inform the bus controlled that sum event or problem has occurred. These have no effect on the instrument and may be ignored. In response to a serial poll or the SRQV command the 2608 will supply a number. this has the meaning given in table below.

SRQ No.	Meaning
0	OK
74	Completed
96	Invalid command
98	SRQ stack point overflow
99	Command buffer overflow
100	Selection Failure
101	Not allowed when Local
102	Syntax error (parameter field)
103	Number out of range
104	Length error (bulk transmissions)
105	Checksum error.

Sending and Receiving Stores

The contents of the display trace memories and the trace memories present a few problems for bus transfers. They may be too large to fit into the bus controller's buffer, and they may also require a considerable amount of time to transfer.

The problem of size is handled by breaking the data into BLOCKS (with the exception of binary – see Binary Data Transfers). The 2608 will transmit blocks of no more than the number of characters set by the BLL command. Each block will be terminated by <cr><lf>, with EOI marking the last block in GPIB. The breaks must occur between data points and EOI must not be asserted.

The data points are separated by commas. To terminate a block it is merely necessary to replace a comma with <cr><lf>. When mass data is sent to the instrument, the size of the block is not important and BLL need not correspond to the actual block length being transmitted.

The speed problem can minimized by specifying an appropriate numeric base using the NB command:

Decimal – for simple entry into BASIC machines
Binary – for maximum transfer speed

Octal and Hexadecimal – to minimize conversion time on machines using these bases.

When mass data is sent to the 1600, the numeric base is deduced from the header and need not correspond to the current setting of NB.

If EOI is sent with any character, the instrument will interpret this as meaning the transfer is terminated (unless the command EOI-OFF has been received).

The format of the transmitted data is the same as that of the received data; thus the store can be read, saved and then returned at some later date.

Mass Data Format

Mass data transfers have three parts:

1. A header which is specific to the command, e.g. 'TRC1A='.
2. A numeric base specifier:
   #B – Binary
   #O – Octal
   #H – Hexadecimal
   None required – Decimal
3. The data points themselves. There are 1000/35 levels per division

Binary Data Transfers

This mode is only available for GPIB transfers.

Sending data in this format is the quickest method, only 1038 bytes are required. In this base the data is not blocked. The format is:

'TRC1A=#BLLdddd.....ddddCC<cr><lf>'

Where:

#B	is the binary numeric base identifier;
LL	is a two byte count of the following data and the checksum. LL is transmitted high byte first.
dddd.dddd	are the 1024 8–bit binary data points.
CC	is the two byte checksum transmitted high byte first. The checksum is the sum of all the data bytes ignoring the overflows.

If the transmitted value of LL is incorrect, service request 104 'length error' is sent and the command terminated. If the checksum is incorrect then the service request 105 is generated (checksum error). All the data points will have been loaded into the store.

The following BASIC program builds up a string containing the header, length, data and checksum for a sample waveform, in this case four ramps. Output of the string to the instrument over GPIB has not been included as this is dependent upon the computer used.

```
 10 DIM A$(1038)
 20 C=0                          'Initialize the checksum
 30 A$="TRC1A=#B"
 40 A$=A$&CHR$(4)&CHR$(2)
 50 'Append header, identifier and length
 60 FOR I=1 TO 1023              '1024 Data points
 70 X=I MOD 256                  'Generate a ramp
 80 A$=A$&CHR$(X)
 90 C=(C+X) MOD 65536            'Update the checksum
100 NEXT I
110 A$=AS&CHR$(C DIV 256)  'Checksum high byte
120 A$=A$&CHR$(C MOD 256) 'Checksum low byte
130 A$=A$&CHR$(13)              'Append <cr>
140 A$=A$&CHR$(10)              'Append <lf>
150 'Now send the string.
```

Decimal Data Transfers

In this format numbers are sent in ASCII decimal with leading zeros suppressed. This results in transmissions of variable length. The format is as follows:

1. The appropriate header is followed by 1024 decimal numbers separated by comma or <cr><lf>.
2. Numbers are in the range –128 to +127 with zero corresponding to the center of the screen and –128 the bottom.
3. Leading zeros are suppressed on output but are acceptable on input.
4. Leading '+' is suppressed on output but is acceptable on input Plus is assumed if no sign is present.
5. Decimal points or exponents are not accepted
6. <cr><lf> is output to separate blocks.
7. Data can be separated by either <cr><lf> or commas. Block length is irrelevant when transmitting data to the instrument.
8. Transmission is terminated when either EOI is received, if selected, or 1024 data bytes have been received.

Octal Data Transfers

Octal numbers are transmitted in ACSII coded octal. The format is as follows:

1. The header is followed by 1024 three-character octal numbers separated by commas or <cr><lf>.
2. The numbers are unsigned and in the range 000 to 377, with 000 corresponding to the bottom of the screen.
3. Leading zeros are transmitted but suppression is acceptable on the input.
4. <cr><lf> is output to separate blocks.
5. Data can be separated by either <cr><lf> or commas. Block length is irrelevant when transmitting data to the instrument.
6. Transmission is terminated when either EOI is received, if selected, or 1024 data bytes have been received.

Hexadecimal Data Transfers

Hexadecimal numbers are transmitted in ACSII as two hex digits. The format is as follows:

1. The header is followed by 1024 two-character hexadecimal numbers separated by commas or <cr><lf>.
2. The numbers are unsigned and in the range 00 to FF, with 00 corresponding to the bottom of the screen.
3. Leading zeros are transmitted but suppression is acceptable on the input.
4. <cr><lf> is output to separate blocks.
5. Data can be separated by either <cr><lf> or commas. Block length is irrelevant when transmitting data to the instrument.
6. Transmission is terminated when either EOI is received, if selected, or 1024 data bytes have been received.

5.3 GPIB/RS423 Commands

There now follows a summary of the interface commands which is in turn followed by detailed descriptions of the commands. Both these sections are presented in alphabetical order.

In order to maintain software compatibility with other Gould's oscilloscopes, many of the commands or their parameters include an extra character, 'A', which would not at first sight seem to be necessary. For example TRC1A where TRC1 would seem to be a sufficient abbreviation. The inclusion of the 'A' allows the same software to control both the 2608 and certain other Gould oscilloscopes without the need to rewrite it.

5.3.1 GPIB/RS423 Command Summary

This section lists the GBIB and RS423 command set. For detailed descriptions of each command see section 5.3.2.

Command	Parameter	Function	Type
ABORT	Abort activity		D
ADD12	ON	Add channels 1 & 2	A,I
	OFF		
ADD34	ON	Add channels 3& 4	A,I
	OFF		
ADD56	ON	Add channels 5 & 6	A,I
	OFF		
ADD78	ON	Add channels 7 & 8	A,I
	OFF		
ADD*	ON	Add all channel pairs	A,I
	OFF		
ADD**	ON	Add all channel pairs	A,I
	OFF		
ALL		Machine status	I
ARM		Arm the instrument	D
AUTCAL	ENABLE	Enable/disable	A,I
	DISABLE	autocal function	A,I
	FORCE		D
AUTSET		Auto set-up	D
BL	number	Block length	A,I
BLL	number	Block length (transfer)	A,I
CCAL		Cursor calculations	I
CH*	ON	Channel selection	A,I
	OFF		
CSRHPnumber		Cursor horizontal position	A,I
CSRTR1A	Cursor trace selection		A,I
	:		
	8A		
	OFF		
CSRVP	Cursor vertical position		I
DATE	dd,mm,yy	Current date	A,I
DATMH	number	Horizontal datum position	A,I
DATMV	number	Vertical datum position	A,I
DISPLAY	MENU0	Display menu or traces	A,I
	:		
	MENU8		
	TRACE		
ECHO	ON	RS423 echo	A,I
	OFF		
EOI	ON	GPIB End or identify	A,I
	OFF		
GLDETOFF	Glitch detection		A,I
	MAX		
	MIN		
	MAXMIN		
HE	OFF	Horizontal expansion	A,I
	1		
	2		
	5		
	10		
	20		
	50		
	100		
	200		
HELLO	Hello message		I
HELP		Command list	I
HOLDALL	ON	Hold all channels	A,I
	OFF		
HOLD*ON	Hold channel		A,I
	OFF		
HSA	number	Horizontal scaling	A,I
INT	DOT	Interpolation type	A,I
	DOTJ		
INV*	ON	Channel invert	A,I
	OFF		
LOCAL	Return to Local operation		D
MEM*	TRC1A	Reference memory transfer	A,I
	:		
	TRC8A		
	data field		

MEM*HS	number	Ref. mem. horizontal scale	A,I
MEM*VS	number	Ref. mem. vertical scale	A,I
MODE	ROLL	Acquisition mode	A,I
	REFR		
	XY		
MSAV*	Save machine set-up		D
MSTX*data field		Transmit machine set-up	A,I
NB	BIN	Number base	A,I
	DEC		
	HEX		
	OCT		
PBG*	X1	Probe gain	A,I
	X10		
	X100		
	X1000		
PH+		Advance trigger event by 1	D
PH–		Retard trigger event by 1	D
PLOT		Start plot	D
PLTALP	ON	Plot Alpha characters	A,I
	OFF		
PLTDST	GPIB	Plot destination	A,I
	PRNT		
	SRL		
PLTGT	SOLID	Plot graticule	A,I
	BROKEN		
	OFF		
PLTMDAUTO		Plot mode	A,I
	MANUAL		
PROMPT	ON	RS423 prompt	A,I
	OFF		
RCLMS*		Recall machine set-up	D
REL		Release	D
SHFT	number	Horizontal shift	A,I
SPL*A	2	Split Screen Mode	A,I
	4		
	8		
	NORM		
SRQV		Service request value	I
STAT		Acquisition status	I
STR*A		Acquisition store transfer	I

TBANDnumber		Trigger band width	A,I
TDELAnumber		Trigger delay by time	A,I
TDUALON	Dual trigger mode		A,I
	OFF		
TEVNTnumber		Trigger delay by events	A,I
TGAAUT	ON	Auto trigger	A,I
	OFF		
TIME	hh,mm,ss	Time	A,I
TLA	number	Trigger level	A,I
TRGCADC	Trigger coupling		A,I
	AC		
	ACHFR		
	DCHFR		
TRGMDA	A	Trigger mode	A,I
	ADIVN		
	ADELN		
TRC*AMEM1		Display trace transfer	A,I
	MEM8		
	data field		
TRHS*A	number	Horizontal trace scaling	A,I
TRVS*A	number	Vertical trace scaling	A,I
TSA	CH1	Trigger source	A,I
	:		
	CH8		
	EXT		
	LINE		
	ODD CHANNEL		
	EVEN CHANNEL		
TSLA	PLUS	Trigger slope	A,I
	MINUS		
	BAND		
TXT*	string	On screen text	A,I
VC*	AC	Vertical coupling	A,I
	DC		
	COM		
VP*	number	Vertical position	A,I
VPS*A	number	Post Storage shift	A,I
VS*	number	Vertical scaling	A,I
WIND	number,number	Trace window	A,I

5.3.2 GPIB/RS423 Command Detail

This section contains a list of all the interface commands in alphabetical order. Each command has all its variations shown, together with an explanation of what it does and any error codes it can cause to be generated. Finally some examples of each command and the instrument response are shown.

Function: **Abort activity**

Type: Direct action assertive

Syntax: ABORT

Explanation: This command causes any abortable activity except remote task to be aborted e.g. plots.

Examples: ABORT

Function: **Add Channels 1 and 2**

Type: Assertive, Interrogative

Syntax: ADD12
ADD12=[ON] or [OFF]

Explanation: This command causes input channels 1 and 2 to be added together before being digitized. The resulting trace is placed in the channel 1 store.

Examples: ADD12
'ADD12=ON' (2608 response)

ADD12=OFF

See also: Section 1.7.4

Function: **Add Channels 3 and 4**

Type: Assertive, Interrogative

Syntax: ADD34
ADD34=[ON] or [OFF]

Explanation: This command causes input channels 3 and 4 to be added together before being digitized. The resulting trace is placed in the channel 3 store.

Examples: ADD34
'ADD34=ON' (2608 response)

ADD34=OFF

See also: Section 1.7.4

Function: **Add Channels 5 and 6**

Type: Assertive, Interrogative

Syntax: ADD56
ADD56=[ON] or [OFF]

Explanation: This command causes input channels 5 and 6 to be added together before being digitized. The resulting trace is placed in the channel 5 store.

Examples: ADD56
'ADD56=ON' (2608 response)

ADD56=OFF

See also: Section 1.7.4

Function: **Add Channels 7 and 8**

Type: Assertive, Interrogative

Syntax: ADD78
ADD78=[ON] or [OFF]

Explanation: This command causes input channels 7 and 8 to be added together before being digitized. The resulting trace is placed in the channel 7 store.

Examples: ADD78
'ADD78=ON' (2608 response)

ADD78=OFF

See also: Section 1.7.4

Function: **Add All Channel Pairs**

Type: Assertive, Interrogative

Syntax: ADD*
ADD*=[ON] or [OFF]

Explanation: This command causes all the channel pairs 1&2, 3&4, 5&6, and 7&8 to be added together before being digitized. the resulting traces are placed in channel stores 1,3,5 and 7 respectively

Examples: ADD*
'ADD*=ON' (2608 response)

ADD=OFF

See also: Section 1.7.4

Function: **Add All Channel Pairs**

Type: Assertive, Interrogative

Syntax: ADD**
ADD**= [ON] or [OFF]

Explanation: This command has exactly the same function as the previous one ADD*.

Examples: ADD**
'ADD**=ON' (2608 response)

ADD=OFF

See also: Section 1.7.4

Function: **Complete Machine Status**

Type: Interrogative

Syntax: ALL

Explanation: This command causes the 2608 to output its complete status as though all the relevant interrogative commands had been sent. The 2608's response will be a number of strings each separated by a semi–colon. If the block length is non–zero, each block will be separated by <cr><lf>, with EOI (if selected) set on the final <lf>.

Examples: ALL
'ADD12=ON;....;WIND=0,1007<cr><lf>'

See also: HELP

Function: **Arm**

Type: Direct action assertive

Syntax: ARM

Explanation: This command produces the same effect as pressing the front panel **S/Shot** button (9). Service request 74 will be generated when the instrument has been armed. If, for some reason, the trace cannot be captured, service request 100 will be generated.

Notes: It is not possible to arm the instrument with this command if:

a) All the traces are held.

b) The instrument is in Local.

c) The instrument is in menu mode.

See also: REL, Section 2.3

Function: **Autocal**

Type: Assertive, Interrogative

Syntax: AUTCAL
AUTCAL=[ENABLE], [DISABLE] or [FORCE]

Explanation: This command enables or disables the auto calibration function in the instrument which balances the DC offsets in the Y pre-amplifiers. A calibration can also be forced thus ensuring that the instrument is calibrated. When an Autocal is forced, service request 74 is generated when the calibration is complete.

Notes: When the instrument is in any of the following modes, auto calibrations are inhibited:

a) Divide by N Trigger.

b) Roll at Timebase speeds slower than 200ms/div

c) Menu Mode

d) Armed waiting for trigger.

Examples: AUTCAL
'AUTCAL=ENABLE' (2608 response)

AUTCAL=FORCE

See also: Section 3.8

Function: **Auto Set-up**

Type: Direct action assertive

Syntax: AUTSET

Explanation: This command produces the same effect as pressing the front panel **Auto Set-up** button (48). Service request 74 is generated when the set–up is complete.

Examples: AUTSET

See also: Section 1.5.1

Function: **Block Length**

Type: Assertive, Interrogative

Syntax: BL
BL=number
BLL
BLL=number

Explanation: This command defines the length of the blocks used during bulk transmissions. Its default state is zero, which selects infinite length blocks. Values from 0 to 256 may be used. Apart from zero, these specify the maximum number of characters that will be sent before a <cr><lf>. Note that if leading zero suppression and decimal numeric base are used, each block may be a different length.

Notes: The number specified is the maximum number of characters that will be sent before <cr><lf>. If leading zero suppression is used in decimal number base, each block may be of different length.

Examples: BL
'BL=0' (2608 response)
BLL=73

See also: NB, EOI, WIND, Section 5.2

Function: **Cursor Calculations**

Type: Interrogative

Syntax: CCAL

Explanation: This command forces the instrument to make voltage and time measurements using the cursors. The voltage is returned first, followed by the time measurement. If the cursors are not selected when this command is issued, a service request 100 will be generated.

Examples: CCAL
'CCAL=CH1:7.261:500.0E-6' (2608 response)

See also: Section 2.5

Function: **Channel Selection**

Type: Assertive, Interrogative

Syntax: CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH*
CH1=[ON] or [OFF]
CH2=[ON] or [OFF]
CH3=[ON] or [OFF]
CH4=[ON] or [OFF]
CH5=[ON] or [OFF]
CH6=[ON] or [OFF]
CH7=[ON] or [OFF]
CH8=[ON] or [OFF]
CH*=[ON] or [OFF]

Explanation: This command switches on or off one or more of the vertical channels. CH* returns the state of all eight channels or switches them all on or off. When a channel is switched back on, its vertical scaling will revert to the value it had prior to the channel being switched off.

Note: The assertive form of the command is not allowed in menu mode. If sent a service request 100 will be generated.

Examples: CH1
'CH1=ON' (2608 response)
CH2=OFF

See also: Section 1.5.2

Function: **Cursor, Horizontal Position**

Type: Assertive, Interrogative

Syntax: CRSHP
CRSHP=number

Explanation: In its assertive form this command moves the measurement cursor to the specified horizontal position across the screen. The range is 0 to +10, zero being the left–hand edge and +10 the right–hand edge. In its interrogative form the horizontal position of the cursor is returned. The resolution of this command is 0.035 divisions.

Examples: CSRHP
'CSRHP=3.7' (2608 response)

CSRHP=5

See also: CRSVP, DATMH, DATMV, Section 2.5

Function: **Cursor, Trace Selection**

Type: Assertive, Interrogative

Syntax: CSRTR
CSRTR=[1A], [2A], [3A], [4A], [5A], [6A], [7A], [8A] or [OFF]

Explanation: This command moves the cursor and datum lines to the specified trace, or indicates on which trace they will appear when they are selected. If Off is sent, the lines will be switched off. The cursor and datum lines can only be moved to a trace that is currently being displayed.

Examples: CSRTR
'CSRTR=2A' (2608 response)

CSRTR=5A

See also: Section 2.5

Function: **Cursor, Vertical Position**

Type: Interrogative

Syntax: CSRVP

Explanation: The vertical position of the cursor is determined by its position on the selected trace. This has a range of –4.48 to +4.45 with zero being the center of the display. The resolution of this command is 0.035 divisions

Examples: CSRVP
'CSRVP=4.1' (2608 response)

See also: CRSHP, DATMH, DATMV, Section 2.5

Function: **Date**

Type: Assertive, Interrogative

Syntax: DATE
DATE=mm,dd,yy

Explanation: This command allows the internally held date to be set or read.

Examples: DATE
'DATE=14,07,89' (2608 response)

DATE=25,12,90

See also: TIME, Section 3.9

Function: **Time Datum Position**

Type: Assertive, Interrogative

Syntax: DATMH
DATMH=number

Explanation: In its assertive form this command moves the time datum line to the specified position across the display. The range is 0 to +10.23, zero being the left–hand edge and +10.23 the right–hand edge. In its interrogative form the horizontal position of the datum line is returned. The resolution of this command is 0.035 divisions.

Examples: DATMH
'DATMH=3.7' (2608 response)

DATMH=9.4

See also: CSRHP, CSRVP, DATMV, Section 2.5

Function: **Voltage Datum Position**

Type: Assertive, Interrogative

Syntax: DATMV
DATMV=number

Explanation: In its assertive form this command moves the voltage datum line to the specified position up the display. The range is –4.48 to +4.45, zero being the center of the display. In its interrogative form the vertical position of the datum line is returned. The resolution of this command is 0.035 divisions.

Examples: DATMV
'DATMV=1.35' (2608 response)

DATMV=0.5

See also: CSRHP, CSRVP, DATMH, Section 2.5

Function: **Display Menus or Traces**

Type: Assertive, Interrogative

Syntax: DISPLAY
DISPLAY=[TRACE] or [MENU][number]

Explanation: This command controls whether traces or menus are displayed. If menus are chosen, the required menu number should be included in the command:

MENU0	Master Menu
MENU1	Status Menu
MENU2	Acquisition/Trigger Menu
MENU3	Display Menu
MENU4	Save/Recall Set-up Menu
MENU5	Plot Menu
MENU6	Special Functions Menu
MENU7	RS423 or GPIB Interface Menu
MENU8	Option Functions Menu

The trace display consists of those traces selected by the CH* command.

Examples: DISPLAY
'DISPLAY=MENU4' (2608 response)

DISPLAY=TRACE

See also: CH*, Section 3

Function: **RS423 Echo**

Type: Assertive, Interrogative

Syntax: ECHO
ECHO=[ON] or [OFF]

Explanation: This command turns the RS423 echo mode on and off so that the 2608 will or will not echo back to the controller any inputs it receives. This command is only available in RS423 mode. ECHO=ON should be used when the instrument is connected to a dumb terminal.

Examples: ECHO
'ECHO=ON' (2608 response)

ECHO=OFF

See also: Section 3.10

Function: **GPIB End Or Identify**

Type: Assertive, Interrogative

Syntax: EOI
EOI=[ON] or [OFF]

Explanation: When EOI is assertive with <lf> this indicates the end of the present transmission. If EOI is set to off then EOI will be ignored if it is asserted. This command is only available with the GPIB interface.

Examples: EOI
'EOI=ON' (2608 response)

EOI=OFF

See also: Section 5.2

Function: **Glitch Detection**

Type: Assertive, Interrogative

Syntax: GLDET
GLDET=[ON], [MAX], [MIN] or [MAXMIN]

Explanation: This command is used to select the glitch detect mode. When Max is selected, the acquired data represents all the maximum values captured by the instrument. When MIN is selected, the acquired data represents all the minimum vales captured.

When MAXMIN is selected the acquired data represents both the maximum and minimum values captured. In this case, adjacent data points consist of the maximum and minimum data values for each period. These will be displayed in their correct time order.

Examples: GLDET
'GLDET=OFF' (2608 response)

GLDET=MAX

See also: Section 3.4

Function: **Horizontal Expansion**

Type: Assertive, Interrogative

Syntax: HE
HE=[OFF], [1], [2], [5], [10], [20], [50], [100] or [200]

Explanation: This command allows the present X magnification to be interrogated or a new value set. Selections 1 and OFF both set the expansion to a factor of 1, i.e off.

Examples: HE
'HE=20' (2608 response)

HE=1

Notes: In the same way as the front panel control, this command expands the trace around the center of the screen.

See also: HSA, Section 1.6.4

Function: **Hello Message**

Type: Interrogative

Syntax: HELLO

Explanation: This command returns the message 'Gould 2608, Software issue no', where the issue number shows the issue of the software fitted to the instrument. For other sets in the 2600 family, 2608 in the message changes accordingly.

Function: **Command List**

Type: Interrogative

Syntax: HELP

Explanation: When this command is issued, the 2608 responds with a list of all the allowable commands and their inputs.

See also: ALL

Function: **Hold All Channels**

Type: Assertive, Interrogative

Syntax: HOLDALL
HOLDALL=[ON] or [OFF]

Explanation: This command, when asserted, Holds all channel traces even if part way through an acquisition. Once the display has been held, individual channels may be held using the HOLD* command. Channels so held will remain held when holdall is turned off.

The assertive form of this command is not allowed in menu mode, if sent it will result in a service request 100.

Examples: HOLDALL
'HOLDALL=OFF' (2608 response)

HOLDALL=ON

See also: HOLD, Section 2.3.1

Function: **Channel Hold**

Type: Assertive, Interrogative

Syntax: HOLD1
HOLD2
HOLD3
HOLD4
HOLD5
HOLD6
HOLD7
HOLD8
HOLD*
HOLD1=[ON] or [OFF]
HOLD2=[ON] or [OFF]
HOLD3=[ON] or [OFF]
HOLD4=[ON] or [OFF]
HOLD5=[ON] or [OFF]
HOLD6=[ON] or [OFF]
HOLD7=[ON] or [OFF]
HOLD8=[ON] or [OFF]
HOLD*=[ON] or [OFF]

Explanation: This command is used to turn on or off individual channel holds. The HOLD* form of this command is used to turn on all the individual channel holds. The hold action is applied immediately even if the instrument is part way through an acquisition.

The assertive form of this command is not allowed in menu mode, if sent it will result in a service request 100.

Examples: HOLD 3
'HOLD3=OFF' (2608 response)

HOLD2=ON

See also: HOLDALL, Section 2.3.1

Function: **Horizontal Scaling**

Type: Assertive, Interrogative

Syntax: HSA
HSA=number

Explanation: The horizontal scaling, or timebase, can be set with this command. The range is 50µs to 200s per division in 1, 2, 5 steps. No action is taken if an incorrect range is requested.

Examples: HSA
'HSA=100E-6' (2608 response)

HSA=5E-3

See also: HE, TRHS*A, Section 1.6.1

Function: **Interpolation (Dot Join)**

Type: Assertive, Interrogative

Syntax: INT
INT=[DOT] or [DOTJ]

Explanation: This command is used to set the interpolation on the displayed traces.

DOT displays only the acquired data points; in expanded mode these individual points can be clearly seen. This mode is called OFF in the Acquisition/Trigger Menu.

In DOTJ mode the discrete dots are joined by faint straight lines. This mode is called ON in the Acquisition/Trigger Menu.

Examples: INT
'INT=DOT' (2608 response)

INT=DOTJ

See also: HE, Section 3.5

Function: **Channel Invert**

Type: Assertive, Interrogative

Syntax: INV1
INV2
INV3
INV4
INV5
INV6
INV7
INV8
INV*
INV1=[ON] or [OFF]
INV2=[ON] or [OFF]
INV3=[ON] or [OFF]
INV4=[ON] or [OFF]
INV5=[ON] or [OFF]
INV6=[ON] or [OFF]
INV7=[ON] or [OFF]
INV8=[ON] or [OFF]
INV*=[ON] or [OFF]

Explanation: This command, in its assertive form, controls whether the channels are displayed in their normal of inverted modes. INV* is used to set or interrogate all channels.

Examples: INV4
'INV4=OFF' (2608 response)

INV7=ON

See also: Section 1.5.2

Function: **Local**

Type: Direct action assertive

Syntax: LOCAL

Explanation: This command is used to return the control of the instrument to the front panel controls from the GPIB.

Examples: LOCAL

See also: Section 5.2

Function: **Reference Memory Transfer**

Type: Assertive, Interrogative

Syntax: MEM1
MEM2
MEM3
MEM4
MEM5
MEM6
MEM7
MEM8
MEM1=[TRC1A], ...[TRC8A]
MEM2=[TRC1A], ...[TRC8A]
MEM3=[TRC1A], ...[TRC8A]
MEM4=[TRC1A], ...[TRC8A]
MEM5=[TRC1A], ...[TRC8A]
MEM6=[TRC1A], ...[TRC8A]
MEM7=[TRC1A], ...[TRC8A]
MEM8=[TRC1A], ...[TRC8A]

Explanation: This command either returns the contents of the internal memories or copies a trace to an internal memory. This is the same as the Save Trace to Memory command on the Display Menu.

By substituting a data stream for TRC1A in the command, a waveform from the host computer can be transferred to a memory. This data stream should be in the same form as the 2608 response to the interrogative form of this command.

Examples: MEM5
'MEM5=34,46,58,...,<cr><lf>' (2608 response)

MEM1=TRC7A (copies trace 7 to memory 1)

Note: Data is always transferred in uncompressed form regardless of the current split screen settings.

See also: MEM*HS, MEM*VS, Section 3.5

Function: **Reference Memory, Horizontal Scaling**

Type: Assertive, Interrogative

Syntax:
MEM1HS
MEM2HS
MEM3HS
MEM4HS
MEM5HS
MEM6HS
MEM7HS
MEM8HS
MEM1HS=number
MEM2HS=number
MEM3HS=number
MEM4HS=number
MEM5HS=number
MEM6HS=number
MEM7HS=number
MEM8HS=number

Explanation: This command is used to set or interrogate the reference memory horizontal scaling. The range is 50µs to 200s in 1, 2, 5 steps.

Examples:
MEM3HS
'MEM3HS=200E–3' (2608 response)

MEM2HS=20

See also: MEM*VS

Function: **Reference Memory, Vertical Scaling**

Type: Assertive, Interrogative

Syntax:
MEM1VS
MEM2VS
MEM3VS
MEM4VS
MEM5VS
MEM6VS
MEM7VS
MEM8VS
MEM1VS=number
MEM2VS=number
MEM3VS=number
MEM4VS=number
MEM5VS=number
MEM6VS=number
MEM7VS=number
MEM8VS=number

Explanation: This command is used to set or interrogate the reference memory vertical scaling. The range is from 10mV to 5V in 1, 2, 5 steps

Examples:
MEM8VS
'MEM8VS=50E–3' (2608 response)

MEM1VS=2

See also: MEM*HS

Function: **Acquisition Mode**

Type: Assertive, Interrogative

Syntax:
MODE
MODE=[ROLL], [REFR] or [XY]

Explanation: This command is used to set the instrument to one of the three possible capture modes.

Roll: Chart recorder mode. The data rolls across the display from the right to the left even in the absence of triggers. This is only valid at timebase ranges of 200ms/div and slower. At faster ranges REFR and ROLL are indistinguishable.

Refr: Refresh mode. Data is displayed from left to right across the screen, after a valid trigger has ben received.

XY: XY mode. Channel 1 is displayed as the X or horizontal component of the displayed trace and the other channels as the Y or vertical components.

Examples:
MODE
'MODE=REFR' (2608 response)

MODE=XY

See also: Section 2.4, 3.5

Function: **Save Machine Set-up**

Type: Direct action assertive

Syntax:
MSAV1
MSAV2
MSAV3
MSAV4

Explanation: This command provides the same function as the Save part of the Save and Recall Setting Menu. When used the present machine set-ups are saved to the specified memory.

Examples: MSAV2

See also: MSTX*, RCLMS, Section 3.6

Function: **Transmit Machine Set-up**

Type: Assertive, Interrogative

Syntax: MSTX1
MSTX2
MSTX3
MSTX4

Explanation: This command transmits the machine set–up so that the number of saved set–ups can be extended. The data sent by this command is a series of numbers. The format of the numbers is defined by NB and BLL. **Warning:** The data field can only be read from and copied back to the instrument. Attempts to modify or construct set-ups can cause the instrument software to crash.

Examples: MSTX1
'MSTX1=data field <cr><lf>' (2608 response)

MSTX3=data field <cr><lf>

See also: MSAV*, RCLMS, Section 3.6

Function: **Number Base**

Type: Assertive, Interrogative

Syntax: NB
NB=[BIN], [DEC], [HEX] or [OCT]

Explanation: This command specifies the number base used during bulk data transfers. There are four possible number bases.

Bin: Binary. Each byte transferred represents the data for one sample. This is the fastest transfer mode. The range is from 00000000 to 11111111. Where 0000000 is the bottom of the screen and 11111111 is the top. The center of the screen is given by 10000000.

Dec: Decimal. Each data sample is sent as a signed decimal number. The range is -128 (bottom of screen) to +127 (top of screen). The middle of the screen is given by 0. This is the slowest transfer mode.

Hex: Hexadecimal. Each data sample is sent as two unsigned hex digits. The range is 00 (bottom of screen) to FF (top of screen). The middle of the screen is given by 80.

Oct: Octal. Each data sample is sent as three unsigned octal digits. The range is 000 (bottom of screen) to 377 (top of screen). The middle of the screen is given by 200.

Notes: The number base defaults to decimal – DEC – on power up and the selected number base is used for transmitting data. The numeric base for received data is specified in the header of the bulk transfer. Any numbers received outside the range of the specified number base will generate a service request 103.

Examples: NB
'NB=DEC' (2608 response)

NB=BIN

See also: BL, BLL, EOI, WIND, Section 5.2

Function: **Probe Gain**

Type: Assertive, Interrogative

Syntax: PBG1
PBG2
PBG3
PBG4
PBG5
PBG6
PBG7
PBG8
PBG*
PBG1=[X1], [X10], [X100] or [X1000]
PBG2=[X1], [X10], [X100] or [X1000]
PBG3=[X1], [X10], [X100] or [X1000]
PBG4=[X1], [X10], [X100] or [X1000]
PBG5=[X1], [X10], [X100] or [X1000]
PBG6=[X1], [X10], [X100] or [X1000]
PBG7=[X1], [X10], [X100] or [X1000]
PBG8=[X1], [X10], [X100] or [X1000]
PBG*=[X1], [X10], [X100] or [X1000]

Explanation: This command sets the gain at the probe input, or reads the currently set value. Probe setting is not automatic; a value must be set using this command unless the default value of X1 is satisfactory. The PBG* form of this command sets or reads the probe gain for all channels.

Examples: PBG7
'PBG7=X10' (2608 response)

PBG4=X1000

See also: Section 3.4

Function: **Phase Shift**

Type: Direct action assertive

Syntax: PH+
PH–

Explanation: When the divide by N trigger function is in use, these commands cause the phase of the captured signal to be changed. PH– takes the previous trigger point and PH+ takes the next one.

Examples: PH+

See also: TRGMD, Section 2.2.4

Function: **Start Plot**

Type: Direct action assertive

Syntax: PLOT

Explanation: This command has the same effect as pressing the front panel Plot button (44). Service request 74 will be generated when the plot is complete.

If the plot destination is GPIB, and the plot was request from the front panel or by an RS423 command, the instrument transmits data in talk-only mode. A GPIB device clear will abort the plot.

Examples: PLOT

See also: PLTALP, PLTDST, PLTGT, PLTMD, Section 2.7, 3.7

Function: **Plot Alpha Characters**

Type: Assertive, Interrogative

Syntax: PLTALP
PLTALP=[ON] or [OFF]

Explanation: This command is used to determine whether or not the alphanumeric characters are included in plot outputs.

Examples: PLTALP
'PLTALP=' (2608 response)

PLTALP=OFF

See also: PLOT, PLTDST, PLTGT, PLTMD, Section 2.7, 3.7

Function: **Plot Destination**

Type: Assertive, Interrogative

Syntax: PLTDST
PLTDST=[GPIB], [PRNT] or [SRL]

Explanation: This command determines the plot destination. The three possible choices are; the internal plotter – PRNT, a plotter on the GPIB, or an RS423 plotter – SRL.

Examples: PLTDST
'PLTDST=PRNT' (2608 response)

PLTDST=GPIB

See also: PLOT, PLTALP, PLTGT, PLTMD, Section 2.7, 3.7

Function: **Plot Graticule**

Type: Assertive, Interrogative

Syntax: PLTGT
PLTGT=[SOLID], [BROKEN] or [OFF]

Explanation: This command determines whether or not the graticule is included in plot outputs and if it is whether it is plotted as solid or broken lines.

Examples: PLTGT
'PLTGT=OFF' (2608 response)

PLTGT=SOLID

See also: PLOT, PLTALP, PLTDST, PLTMD, Section 2.7, 3.7

Function: **Plot Mode**

Type: Assertive, Interrogative

Syntax: PLTMD
PLTMD=[AUTO] or [MANUAL]

Explanation: There are two possible plot modes on the 2608, AUTO and MANUAL. In manual mode one plot is output for each PLOT command asserted. In Auto mode when Plot is asserted, a plot is produce, the instrument rearmed and after the next capture a further plot is produced. This process then repeats.

Note: There are four ways to stop the plot and capture sequence once Auto Plots have commenced: Send GPIB device clear, press the Abort button, send the abort command or switch the instrument off.

Examples: PLTMD
'PLTMD=AUTO' (2608 response)

PLTMD=MANUAL

See also: PLOT, PLTALP, PLTDST, PLTGT, Section 2.7, 3.7

Function: **RS423 Prompt**

Type: Assertive, Interrogative

Syntax: PROMPT
PROMPT=[ON] or [OFF]

Explanation: This command alters the Prompt mode in RS423 operation, so that prompts, which indicate a pending SRQ, can be turned on or off. This command is only available in RS423 mode.

Examples: PROMPT
'PROMPT=ON' (2608 response)

PROMPT=OFF

See also: Section 3.10

Function: **Recall Machine Set-up**

Type: Direct action assertive

Syntax: RCLMS1
RCLMS2
RCLMS3
RCLMS4

Explanation: This command recalls one of the internally saved machine set–ups. The settings for all the instruments controls are recalled. Service request 74 is generated when the recall is complete.

Examples: RCLMS2

See also: MSAV*, MSTX*, Section 3.6

Function: **Release**

Type: Direct action assertive

Syntax: REL

Explanation: This command has the same effect as pressing the Run button (12) on the instruments front panel.

Examples: REL

See also: ARM, Section 2.3

Function: **Horizontal Shift**

Type: Assertive, Interrogative

Syntax: SHFT
SHFT=number

Explanation: This command is used to set the horizontal or X position of the traces. The range is ± 5.00 divisions, allowing the ends of the traces to be placed at the center of the screen. A value of zero places the traces nominally in the center of the screen. Negative numbers move the traces to the left and positive numbers move them to the right.

Examples: SHFT
'SHFT=–3.14' (2608 response)

SHFT=2.71

See also: HE, Section 1.6.3

Function: **Split Screen Mode**

Type: Assertive, Interrogative

Syntax: SPL1A
SPL2A
SPL3A
SPL4A
SPL5A
SPL6A
SPL7A
SPL8A
SPL*A
SPL1A=[2], [4], [8], or [NORM]
SPL2A=[2], [4], [8], or [NORM]
SPL3A=[2], [4], [8], or [NORM]
SPL4A=[2], [4], [8], or [NORM]

SPL5A=[2], [4], [8], or [NORM]
SPL6A=[2], [4], [8], or [NORM]
SPL7A=[2], [4], [8], or [NORM]
SPL8A=[2], [4], [8], or [NORM]
SPL*A=[2], [4], [8], or [NORM]

Explanation: This command is used to set or examine the status of the split screen compression mode. When a channel is set to NORM, the compression is off and when it is 2, 4 or 8 the trace is compressed by a factor of 2, 4 or 8 respectively.

Examples: SPL4A
'SPL4A=4' (2608 response)

SPL*A=8

(set all channels to divide by 8 compression)

See also: Section 2.4.1

Function: **Service Request Value**

Type: Interrogative

Syntax: SRQV

Explanation: When an error is generated in the instrument, either through an invalid command or for any other reason, a service request is generated. This command is used to ascertain what the error is in order to determine the cause. The service request numbers generated for various reasons are listed below:

SRQ	Meaning
0	ok
74	completed
96	invalid command
98	SRQ stack overflow
99	command buffer overflow
100	selection failure
101	not allowed when local
102	syntax error in parameter filed
103	number out of range
104	length error
105	checksum error

Note: The last two service request numbers, 104 and 105, are only generated by errors in bulk transmissions.

Examples: SRQV
'SRQV=74' (2608 response)

See also: Section 5.2

Function: **Acquisition Status**

Type: Interrogative

Syntax: STAT

Explanation: This command allows the user to determine which stage the instrument has reached during an acquisition. The four possible states are:

ARMD	Armed but not yet triggered.
FLSHD	Flushing the acquisition store.
TRIGD	Triggered, acquisition in progress.
STORD	Stored, trace acquisition complete.

Examples: STAT
'STAT=TRIGD' (2608 response)

See also: Section 2.3

Function: **Acquisition Store Transfer**

Type: Interrogative

Syntax: STR1A
STR2A
STR3A
STR4A
STR5A
STR6A
STR7A
STR8A

Explanation: This command is used to transfer the acquisition store to the host computer. The store consists of 10240 data samples.

The format of the data field is dependent on the specified block length. If BLL=0 then the data field will consist of 10240 numbers in the chosen number base followed by <cr><lf> with EOI on the last <lf>. If BLL is non-zero, then the data field will consist of a number of blocks each separated by <cr><lf> with EOI, if asserted, on the last <lf>.

This command is not allowed in menu mode, if sent it will result in a service request 100.

Examples: STR7A
'STR7A=4,96,...,12<cr><lf>' (2608 response)

See also: BL, BLL, NB, EOI, WIND, Section 5.2

Function: **Trigger Band**

Type: Assertive, Interrogative

Syntax: TBAND
TBAND=number

Explanation: This command allows the width of the trigger band to be set of changed. The range of values for the width of the band is from 0.5 to 8.0 divisions.

Examples: TBAND
'TBAND=3.7' (2608 response)

TBAND=0.5

See also: TLA, TSLA, Section 2.1.5, 3.4

Function: **Trigger Delay by Time**

Type: Assertive, Interrogative

Syntax: TDELA
TDELA=number

Explanation: This command allows the value of the trigger delay by time function to be read of altered. Negative time delays capture events prior to the trigger point (pre trigger). The amount of pre trigger is expressed as a percentage, e,.g –100.0 (100% pre trigger) places the trigger point on the right hand edge of the screen and 0.0 (0%) places it on the left hand edge.

Positive time delay settings capture events after the trigger point, and are expressed in seconds.

The minimum time delay is –100.0 and the maximum varies with the timebase range with an absolute maximum of 1000 seconds.

Timebase Range	Max Delay
50µs – 2ms	100ms
5ms – 200ms	10s
500ms – 200s	1000s

Examples: TDELA
'TDELA=–50' (2608 response)

TDELA=0.0

See also: TRGMD, TEVNT, section 2.2, 2.2.2, 3.4

Function: **Dual Trigger**

Type: Assertive, Interrogative

Syntax: TDUAL
TDUAL=[ON] or [OFF]

Explanation: This command is used to set or read the dual trigger mode.

Examples: TDUAL
'TDUAL=ON' (2608 response)

TDUAL=OFF

See also: TSA, Section 2.1.2, 3.4

Function: **Trigger Delay by Events**

Type: Assertive, Interrogative

Syntax: TEVNT
TEVNT=number

Explanation: This command is used to set or read the trigger events counter.

If the trigger mode is ADIVN, the incoming triggers are divided by the value in this counter i.e if the counter is set to 5, the acquisition circuit will trigger on each fifth trigger event.

If the trigger mode is ADELN, the value set in the counter represents the number of triggers that are to be counted before the acquisition circuit is triggered. i.e. if the value is set to 5 the circuit will trigger on the sixth event.

The range of values for this counter is from 2 to 16383.

Examples: TEVNT
'TEVNT=1789' (2608 response)

TEVNT=1407

See also: TDELA, TRGMD, Section 2.2.3

Function: **Auto Trigger**

Type: Assertive, Interrogative

Syntax: TGAAUT
TGAAUT=[ON] or [OFF]

Explanation: This command is used to set either Auto or Normal Triggering.

Examples: TGAAUT
'TGAAUT=ON' (2608 response)

TGAAUT=OFF

See also: Section 2.1.6, 3.4

Function: **Time**

Type: Assertive, Interrogative

Syntax: TIME
TIME=HH,MM,SS

Explanation: This command is used to either set or read the time held within the instrument.

Examples: TIME
'TIME=10,51,43' (2608 response)

TIME=1,13,51

See also: DATE, Section 3.9

Function: **Trigger Level**

Type: Assertive, Interrogative

Syntax: TLA
TLA=number

Explanation: This command is used to set or read the trigger level. The range is ±13.00 divisions with 0 nominally corresponding to the middle of the screen.

Note: It is not necessarily possible to relate the trigger level to a particular vertical position on the screen display due to the effects of pre and post storage shift and the selected trigger coupling.

Examples: TLA
'TLA=3.74' (2608 response)

TLA=–1.45

See also: TBAND, TRGCA, TSA, TSLA, Section 2.1.4, 3.4

Function: **Trigger Coupling**

Type: Assertive, Interrogative

Syntax: TRGCA

TRGCA=[DC], [AC], [ACHFR] or [DCHFR]

Explanation: This command is used to set or read the trigger coupling of the instrument. The four possible values are listed below:

Value	Meaning
DC	Direct Coupling
AC	AC coupling
ACHFR	AC High frequency reject (low pass)
DCHFR	DC High frequency reject (low pass)

Examples: TRGCA
'TRGCA=ACHFR' (2608 response)

TRGCA=AC

See also: TBAND, TLA, TSA, TSLA, section 2.1.3, 3.4

Function: **Display Trace Transfer**

Type: Assertive, Interrogative

Syntax: TRC*A
TRC1A
TRC2A
TRC3A
TRC4A
TRC5A
TRC6A
TRC7A
TRC8A
TRC1A=[MEM1] to [MEM8]
TRC2A=[MEM1] to [MEM8]
TRC3A=[MEM1] to [MEM8]
TRC4A=[MEM1] to [MEM8]
TRC5A=[MEM1] to [MEM8]
TRC6A=[MEM1] to [MEM8]
TRC7A=[MEM1] to [MEM8]
TRC8A=[MEM1] to [MEM8]

Explanation: This command is used to transfer the display trace stores to either the host computer or to one the instrument's eight internal stores. Each store consists of 1024 data samples, the first of which corresponds to the left-hand edge of the screen.

The format of the data field is dependent on the specified block length. If BLL=0 then the data field will consist of 1024 numbers in the chosen number base followed by <cr><lf> with EOI on the last <lf>. If BLL is non-zero, then the data field will consist of a number of blocks each separated by <cr><lf> with EOI, if asserted, on the last <lf>.

By substituting a data stream for MEM1 in the command, a waveform from the host computer can be transferred to one of the instrument's eight internal stores. This data stream should be in the same form as the 2608 response to the interrogative form of this command.

TRC*A can only be used interrogatively. It is equivalent to issuing the commands TRC1A, TRC2A...TRC8A sequentially. The instrument responds with the data from each trace in turn.

Examples: TRC*A
'TRC1A=3,20,...,34;TRC2A=3,50,...,45;...
...;TRC8A=3,28,..,7<cr>,<lf>' (2608 response)

TRC7A=MEM2

Note: Data is always transferred in uncompressed form regardless of the current split screen settings.

See also: BL, BLL, NB, EOI, WIND, Section 5.2

Function: **Horizontal Trace Scaling**

Type: Assertive, Interrogative

Syntax:
TRHS*A
TRHS1A
TRHS2A
TRHS3A
TRHS4A
TRHS5A
TRHS6A
TRHS7A
TRHS8A
TRHS*A=number
TRHS1A=number
TRHS2A=number
TRHS3A=number
TRHS4A=number
TRHS5A=number
TRHS6A=number
TRHS7A=number
TRHS8A=number

Explanation: This command can read or change the stored horizontal scaling (timebase) associated with a display trace.

The range is 50µs to 200s per division in 1, 2, 5 steps. The * command either sets or reads the horizontal scaling for all traces.

Note: When the scaling has been changed, the results of any cursor calculations will be based on the new timebase.

Examples: TRHS1A
'TRHS1A=200E–3' (2608 response)

TRHS7A=50E–6

See also: Section

Function: **Vertical Trace Scaling**

Type: Assertive, Interrogative

Syntax:
TRVS*A
TRVS1A
TRVS2A
TRVS3A
TRVS4A
TRVS5A
TRVS6A
TRVS7A
TRVS8A
TRVS*A=number
TRVS1A=number
TRVS2A=number
TRVS3A=number
TRVS4A=number
TRVS5A=number
TRVS6A=number
TRVS7A=number
TRVS8A=number

Explanation: This command can read or change the stored vertical scaling associated with a display trace.

The range is 10mV to 5V per division in 1, 2, 5 steps. The * command either sets or reads the vertical scaling for all traces.

Note: When the scaling has been changed, the results of any cursor calculations will be based on the new value.

Examples: TRVS1A
'TRVS1A=5' (2608 response)

TRVS7A=2E–3

See also: TRHS*A, VS*, Section 1.7.1

Function: **Trigger Source**

Type: Assertive, Interrogative

Syntax: TSA
TSA=[CH1] to [CH8], [EXT], [LINE] or [CH odd, CH even]

Explanation: This command is used to set the trigger source. For dual trigger sources the channel numbers following the command must be the odd channel first followed by the even channel.

Examples: TSA
'TSA=CH7' (2608 response)

TSA=CH5,CH2

See also: TDUAL, Section 2.1.1, 3.4

Function: **Trigger Slope**

Type: Assertive, Interrogative

Syntax: TSLA
TSLA=[PLUS], [MINUS] or [BAND]

Explanation: This command selects the trigger slope which determines whether trigger points are generated on the rising (PLUS) edge, or falling (MINUS) edge of the trigger source. If BAND is selected, trigger points are generated on both the rising and falling edges.

Examples: TSLA
'TSLA=MINUS' (2608 response)

TSLA=PLUS

See also: TBAND, TLA, Section 2.1.5, 3.4

Function: **On Screen Text**

Type: Assertive, Interrogative

Syntax: TXT*
TXTnumber
TXTnumber="string"

Explanation: This command is used to set or read user defined screen text on the 2608 display.

The 2608 has 16 lines each consisting of 32 characters on the display. Line 0 is at the top of the screen and line 15 the bottom.

TXT* is interrogative only and returns all the text currently on the screen. TXTnumber is used to return the text on that line number only.

In its interrogative form, this command always returns a string 32 characters long. When asserted the string can have any number of characters up to and including 32.

TXT0, TXT1 and TXT15 cannot be used assertively.

Note: If the text line is empty than a string of 32 spaces is returned by an interrogative form of this command.

Examples: TXT4
'TXT4="TEST NUMBER 8"' (2608 response)

TXT1="GOULD 2608"

See also: BL, NB

Function: **Vertical Coupling**

Type: Assertive, Interrogative

Syntax: VC*
VC1
VC2
VC3
VC4
VC5
VC6
VC7
VC8
VC*=[AC], [DC] or [COM]
VC1=[AC], [DC] or [COM]
VC2=[AC], [DC] or [COM]
VC3=[AC], [DC] or [COM]
VC4=[AC], [DC] or [COM]
VC5=[AC], [DC] or [COM]
VC6=[AC], [DC] or [COM]
VC7=[AC], [DC] or [COM]
VC8=[AC], [DC] or [COM]

Explanation: This command allows the vertical coupling of the eight input channels to be interrogated or changed. VC* allows all channels to be interrogated or changed together.

Examples: VC7
'VC7=COM' (2608 response)

VC1=AC

See also: VP*, VS*, Section 1.5.3

Function: **Vertical Position**

Type: Assertive, Interrogative

Syntax:
VP*
VP1
VP2
VP3
VP4
VP5
VP6
VP7
VP8
VP*=number
VP1=number
VP2=number
VP3=number
VP4=number
VP5=number
VP6=number
VP7=number
VP8=number

Explanation: This command controls the pre-storage vertical shift position of the traces. The range is ±8.5 divisions where 0.0 is nominally the center of the screen.

VP* returns or set the shift values for all input channels.

Examples:
VP6
'VP6=4.3' (2608 response)

VP4=–7.0

See also: VPS*, Section 1.7.2

Function: **Post Storage Shift**

Type: Assertive, Interrogative

Syntax:
VPS*A
VPS1A
VPS2A
VPS3A
VPS4A
VPS5A
VPS6A
VPS7A
VPS8A
VPS*A=number
VPS1A=number
VPS2A=number
VPS3A=number
VPS4A=number
VPS5A=number
VPS6A=number
VPS7A=number
VPS8A=number

Explanation: This command controls the post-storage vertical shift position of the traces. The range is –4.48 to +4.45 divisions where 0.0 is nominally the center of the screen.
VP* returns or set the shift values for all input channels.

Examples:
VPS5A
'VPS5A=4.0' (2608 response)

VPS1A=1.2

See also: VP*, Section 1.7.2

Function: **Vertical Scaling**

Type: Assertive, Interrogative

Syntax:
VS*
VS1
VS2
VS3
VS4
VS5
VS6
VS7
VS8
VS*=[–], [>], number, [AC] or [DC] or [COM]
VS1=[–], [>], number, [AC] or [DC] or [COM]
VS2=[–], [>], number, [AC] or [DC] or [COM]
VS3=[–], [>], number, [AC] or [DC] or [COM]
VS4=[–], [>], number, [AC] or [DC] or [COM]
VS5=[–], [>], number, [AC] or [DC] or [COM]
VS6=[–], [>], number, [AC] or [DC] or [COM]
VS7=[–], [>], number, [AC] or [DC] or [COM]
VS8=[–], [>], number, [AC] or [DC] or [COM]

Explanation: This command allows the attenuator settings of the input channels to be interrogated or set. The range is 10mV to 5V per division in 1, 2, 5 steps. The assertive form of the command can be used to set the vertical range, and optionally invert the channel by placing a minus sign before the range. The interrogative form of the command returns the range, together with the additional information: invert status, uncal status and input coupling status.

This command cannot be used to set uncal or input coupling. Use the appropriate dedicated commands.

VS* is used to return or set the scaling of all the input channels.

Examples: VS1
'VS1=5' (2608 response)

VS4=2E–3

See also: TRVS*A, VP*, Section 1.7.1

Function: **Trace Window**

Type: Assertive, Interrogative

Syntax: WIND
WIND=number1, number2

Explanation: This command is used in conjunction with the block transfer commands.

It specifies a window on the trace that will be transmitted the next time a block transfer is requested. The range for number1 is 0 to 10238 and for number2 is 1 to 10239. Number2 must always be greater than number1.

Only data samples between the two numbers will be transferred, inclusive.

Note: The TRC*A block transfer command applies to the 1024 byte stores and consequently an error will be returned if this command is issued without previously selecting a trace window of less than 1024. The default window is 0,1023.

Examples: WIND
'WIND=0,1023' (2608 response)

WIND=1,49

See also: TRC*A, STR*A

5.4 Waveform Processor Option 260

The 260 Waveform Processor is for use with the Gould 2608 series Digital Storage Oscilloscopes and is used to add additional capture and manipulation facilities to the standard instrument.

The Waveform processor consists of a keypad and an interface pod/memory module. The 205 memory module has a 50K memory. For further details see Option Functions later on in this section.

Connection

The interface pod fits to the rear of the 2608 as follows:

Disconnect the 2608 from the AC supply.

Connect the 260 Waveform Processor interface to either of the rear panel connectors and tighten the fixing screw until the interface is securely fitted.

The 260 Waveform Processor keypad should then be connected to the interface.

To check the interface has been connected correctly switch on the 2608 and the on screen alphanumerics will display the message

VERSION X.XX + KEYPAD & 205 X.XX

This indicates that the 260 Waveform Processor is connected and recognized by the instrument. Either 205 or 215 will be displayed dependent upon which memory module is fitted. This message may be cleared by operating any front panel key.

Check that the waveform processor is working correctly by pressing the 'SELECT TRACE' key on the keypad, selecting cursors on a displayed trace. The datum and the cursor will be close to the left and right edges of the screen respectively and the reading will be of the form

CH1: 2.5mV 1.23ms

The exact values will depend upon the particular waveform being measured and the voltage and timebase ranges selected.

Button Operation

F (function) The BLUE '2nd level' key is used to select the corresponding 2nd level functions, also printed in blue, available on many of the keys.

Initialise Initialises the Waveform Processor functions. This includes resetting averaging, enveloping and filtering to zero, canceling TV mode triggering, turning off any limit traces, turning off any holds from either limits testing or envelope mode and changing the cursor measurement to voltage and time.

NOTE: It is advisable to press initialise prior to switching off the 2600, because the 2600 will store any waveform processor functions in non volatile memory even if the keypad is removed.

Pressing 'INITIALISE' will NOT delete any programmed sequence present in the waveform processor.

Numeric and Datum Keys The numeric keys on the keypad operate in an identical manner to the corresponding numeric keys on the 2608. They can call up and make selections in all menus and can be used to enter numeric values such as trigger delays.

The datum movement keys on the keypad can be used to make selections in menus in the same way as the datum keys on the front panel of the 2608.

Double Speed Keys Certain keys on the waveform processor keypad have two speeds of operation.

These are 'INC', 'DEC', <, >, ^, v, 'CURSOR <', and 'CURSOR >'. For example, pressing the 'INC' key will increment the Y magnification by a small amount. Fully depressing 'INC' will increment by a much larger step. Similarly, pressing 'CURSOR <' will move the cursor one position to the left. Fully depressing 'CURSOR <' will move the cursor by a larger amount.

5.4.1 Waveform Processor Operation

Time and Voltage Measurement

The waveform processor uses the cursor and datum lines to define the waveform to be manipulated. These lines are described in section 2.5.

The Select Trace, Datum arrows and Cursor Arrows on the keypad function in exactly the same way as the corresponding buttons on the 2608.

To use the Datum arrows, the Datum button has to be pressed. After pressing the 'DATUM' key the four arrow keys control the position of the voltage datum and the time datum. A second press of the Datum button, while the message

PRESS AGAIN TO SET DATUM

is displayed, will set the voltage and time datum to the current cursor position, zeroing the measurement readings.

Cursor voltages are measured with respect to the voltage datum. If split screen mode is turned on then the movement range of this line will be compressed

Cursor time measurements are made with respect to the time datum.

The CURSOR arrow buttons move the cursor horizontally along the selected trace to make a measurement.

Cursor Measurement Modes

The 'CURSOR MODE' key is used to select the type of measurement used when calculating the voltage and time values displayed. Operating this key displays the current cursor measurement mode. Subsequent presses will step through the modes available. When the 2608 is switched on the waveform processor calculates voltage and time measurements based on the figure 5.4.1.

This is described as:

V wrt VOLTAGE DATUM

voltage with respect to the voltage datum) when the cursor mode key is pressed.

A subsequent key press while the above message is displayed will select a mode that calculates voltage and time measurements with respect to the point at which the time datum crosses the trace as shown in fugure 5.4.2.

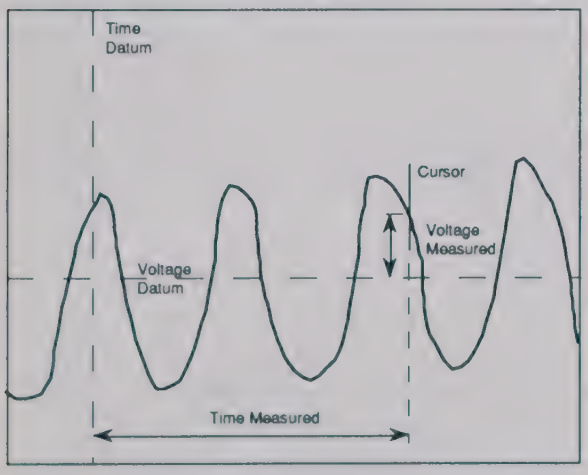


Fig. 5.4.1 Standard Volts/Time Measurement

This is described as:

V wrt VOLTAGE AT TIME DATUM

A further press selects the third measurement mode. The displayed result is the time from the time datum to the last point at which the trace crosses the voltage datum before the cursor. The measurement must always be positive and is made from the time datum towards the cursor as shown in figure 5.4.3. . If the trace does not cross the voltage datum between the time datum and the cursor a value of 0 sec is shown.

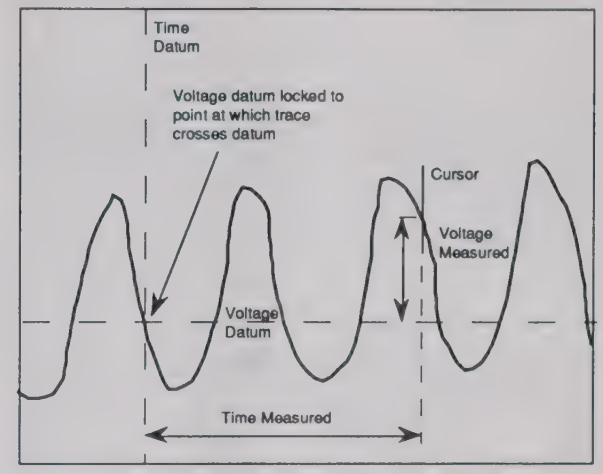


Fig. 5.4.2 V wrt VOLTAGE AT TIME DATUM

This mode is described on the screen as:

T TO LAST CROSSING POINT

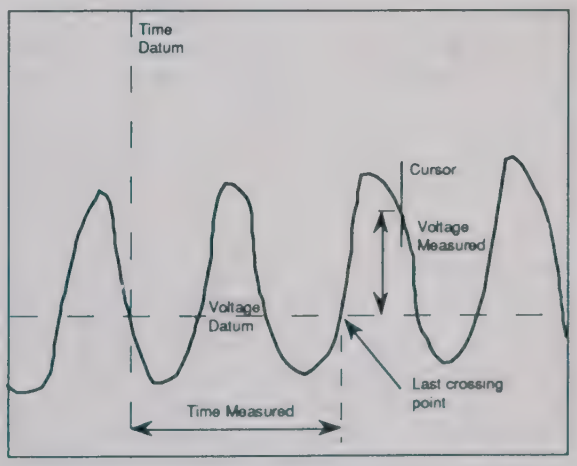


Fig.5.4.3 T TO LAST CROSSING POINT

NOTE:- In the ' V wrt VOLTAGE AT TIME DATUM' mode the voltage datum is fixed to the point at which the trace crosses the time datum. It therefore indicates the reference point for all voltage measurements. In this mode the voltage datum cannot be moved using the normal voltage datum controls. An attempt to do so will produce the message:

VOLTAGE DATUM LOCKED

The level of the voltage can only be changed by moving the time datum.

V&T

Pressing the 'V&T' (Volts and Time) key is equivalent to selecting VOLTAGE wrt VOLTAGE DATUM using the 'CURSOR MODE' key and selecting STANDARD UNITS using the 'dB/%' key (see dB and percentage measurement section). This cancels any other measurement mode and restores cursor measurement to its power on state.

Acquisition Functions

The following waveform processor functions affect the way in which the 2608 captures traces.

Capture

Pressing the 'CAPTURE' key will 'arm' the 2608 to complete a capture after receiving the next trigger. Holding down this key will continuously re-arm the 2608 to accept triggers and update the display.

If averaging has been selected, pressing 'CAPTURE' will result in the set number of traces being captured and averaged. For example, if averaging of 8 traces is selected the pressing 'CAPTURE' will cause 8 traces to be acquired and the running average of these traces will then be displayed.

Similarly, if enveloping has been selected, pressing 'CAPTURE' will cause the set number of traces to be acquired and an envelope of their maximum and minimum values created.

Capture and Repeat

Pressing the 'CAPTURE AND REPEAT' key will arm the 2608 to complete a capture after the next trigger and then perform the last selected post-storage function. The execution of a programmable sequence is regarded as a post-storage function. Therefore, if the last function was the execution of the programmable sequence, then pressing 'CAPTURE AND REPEAT' will result in a further acquisition followed by the re-execution of that sequence.

NOTE: It is advisable to press 'INITIALISE' to reset the waveform processor prior to selecting the required post-storage function. When using 'CAPTURE AND REPEAT' the current measurement mode will be restored after the post-storage function has been performed.

NOTE:- If the currently selected trace is held, the effect of pressing 'CAPTURE AND REPEAT' may not be as expected as 'CAPTURE' does not alter held traces. Therefore the last post-storage function will be performed using the current contents of the selected trace.

TV Mode

Pressing the 'TV MODE' key will set up the 2608 trigger system to + by N trigger mode. Each press of this button steps around the three selections 525, 625 and OFF.

When 525 is selected N is set to 525, and when 625 is selected N is set to 625.

For this mode to function correctly the trigger level should be set so that the instrument triggers on the TV line sync pulses. 'TV LINE' can then be used to select different lines.

Pressing 'INITIALISE' will return the trigger system to the settings prior to the selection of TV mode.

TV Line

This is used in conjunction with the TV Mode button to phase slip the trigger point using the 'INC' (increment) and 'DEC' (decrement) keys. Operating these buttons has the same effect as the phase control in the trigger menu. See section 3.4. In this mode of operation it is not possible to determine which particular TV line number is being displayed because the trigger point is not referenced to any field information.

The 'INC' and 'DEC' controls have three speeds of operation: single step, by pressing the key once; first step slow, achieved by keeping the key depressed so that it repeats; and fast, by fully depressing the key and allowing it to repeat.

Test Limits

This function enables the user to compare an incoming waveform with a pre-defined test band.

The test is carried out on the selected trace over that part of the trace between the time datum and the cursor.

The test band consists of an upper and a lower limit which are displayed as an alternating sequence of data points. During testing the test limits are displayed in the opposite trace of a channel pair as shown in the following table.

Selected Trace	Limits stored in
CH1	CH2
CH2	CH1
CH3	CH4
CH4	CH3
CH5	CH6
CH6	CH5
CH7	CH8
CH8	CH7

The V/Div Channel readout on the display changes from CH* to REF on the limit trace.

Test limits can be derived from an incoming signal or a waveform loaded via the IEEE/RS423 interface. The trace can be positioned, using the 'POSITION' function of the 260, to define the upper or lower limit.

The limits have separate keys, 'SAVE UPPER LIMIT' and 'SAVE LOWER LIMIT' which save the selected trace as the corresponding limit when pressed.

When both limits are set the test limits are shown as a bright band on the screen. The test limits will be held in memory until either the 2608 is switched off or hold is turned off.

NOTE: To avoid changing the input channel position on the 2608 use the 260 'POSITION' function to position a limit waveform.

When both limits are set press the 'TEST LIMIT' key. The message:

PRESS AGAIN TO HALT ON FAIL

will appear on the screen. If the 'TEST LIMIT' key is pressed again while this message is displayed, the 2608 will capture waveforms until the signal on the selected trace deviates outside the test limits.

When this occurs the test limit process will stop and the last trace acquired will be held on the screen.

If AUTOPLOT has been selected on the 2608 any failed trace will be plotted and then the 2608 will be re-armed and will continue testing.

If the 'TEST LIMIT' key is not pressed again, the 2608 will continuously test the selected trace and display the message

LIMITS TEST: PASS

If the signal deviated outside the test limits it will display the message

LIMITS TEST: FAIL

but the 2608 will continue to test traces. When the trace returns inside the test limits the display will again show

LIMITS TEST: PASS

In this mode the test limits process can be aborted at any time by pressing any keypad key.

NOTE: While testing a trace triggers detected by the 2608 do not result in a capture and therefore not all incoming signals can be tested.

Set Average

Pressing the 'SET AVERAGE' key will display the current averaging factor selected; further presses will step through and display the selections available for averaging. The selections available are:

No Averaging, 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1024 traces.

Pressing 'CAPTURE' initiates the averaging process which will be continuous or single shot depending on whether continuous or single shot is selected on the 2608 front panel. All the displayed traces will be averaged.

In continuous capture a running average will be performed using the weighting factor selected. If a single shot capture is selected from the waveform processor, the number of triggered acquisitions is dependent upon the number of averages selected.

Note: In single shot averaging the first acquisition is displayed then the preset number of acquisitions are made at high speed and then resulting averaged waveform is displayed.

Either form of averaging can be stopped by pressing 'ABORT'.

Set Envelope

Pressing the 'SET ENVELOPE' key will display the current enveloping factor selected; further processes will step through the available selections for enveloping and display these settings on the screen.

The selections available are: No Enveloping, 2, 4, 8, 16, 32, 64, 128, 256 traces and Continuous Enveloping.

Pressing 'CAPTURE' initiates the enveloping process for the selected trace, the number of traces acquired depends upon the enveloping factor.

During enveloping the maximum and minimum excursions of the acquired traces are accumulated and displayed as a bright band. The envelope waveform is stored as a channel trace using the opposite trace of a channel pair according to the following table.

Selected Trace	Envelope stored in
CH1	CH2
CH2	CH1
CH3	CH4
CH4	CH3
CH5	CH6
CH6	CH5
CH7	CH8
CH8	CH7

Hold will be turned on for the envelope channel to prevent the envelope waveform from being overwritten by the next acquisition.

Enveloping can be stopped by pressing 'ABORT'.

NOTE: Averaging and enveloping are mutually exclusive. Using 'SET AVERAGE' will cancel any existing enveloping factor and vice-versa.

Wait

'WAIT' prevents the waveform processor from performing any further functions until the 'NEXT' key is pressed. This function is most useful for pausing averaged or enveloped captures. If the 'WAIT' key is pressed while such an acquisition is taking place the capture will be suspended and the message

PRESS NEXT TO CONTINUE

displayed. Pressing 'NEXT' will continue the acquisition.

'WAIT' can also be used as part of a programmed sequence to halt execution until 'NEXT' is pressed.

Post-storage Functions

The following functions will only operate once a trace has been captured or is held. For automatic operation use 'CAPTURE AND REPEAT'. The function is performed on the trace selected by the cursor. To move the cursor to another trace use the 'SELECT TRACE' key.

Y Mag

Selecting 'YMAG' allocates the 'INC' (Increment) and 'DEC' (Decrement) keys to magnify or reduce the waveform identified by the cursor. The range is from x0.062 to x4.0. The magnification value is indicated on the display for a limited time after selection. After magnification is applied all voltage measurements on the magnified trace will be displayed in division units.

If split screen mode is on, then the magnified trace will show the combined effect of Y Mag and the compression ratio.

Inc

The 'INC' key will increase the current magnification or increment the TV line number. The button has two positions and if held in the first the increments will be applied slowly; with the button pushed fully down the increments will be fast.

Dec

The 'DEC' key will decrease the current magnification or decrement the TV line number. The button has two positions and if held in the first the decrements will be applied slowly; with the button pushed fully down the decrements will be fast.

Filter

Pressing 'FILTER' for the first time will display the current filter setting. Subsequent presses will step through the filter stages, returning to the "NO FILTERING" position. There are 6 stages of filter for each timebase range.

The filter is a single pole low pass filter, where the alpha-numeric display indicates the 3dB point.

$$\text{Cut-off frequency} = \left(\frac{15.92}{t}\right) - \ln\left(1 - \frac{1}{2n}\right)$$

Where t = timebase
n = filter step
ln = natural logarithm

Position

The trace identified by the cursor can be moved via the keypad after it has been stored. Pressing 'POSITION' allocates the <, >, ^ and v position controls to shift the selected trace in X and Y. When moved in X, the trace will roll round, disappearing at one edge of the screen and reappearing at the other.

Invert

Pressing 'INVERT' will invert the selected trace about the voltage datum. A record of the original trace is taken and so 'RESTORE' will undo the last action of this function.

Integration

Pressing 'INTEGRATE' will calculate and display the integrated waveform of the selected trace.

The voltage datum is taken as zero for integration. The cursor reads out the value in Vs (Volts-seconds or similar units). If integration is performed twice, the readout will be in Vs^2 or similar units.

Fast Fourier Transform

The Waveform Processor can perform a Fourier transform on any trace captured by the 2608. Pressing 'FFT MENU' ('F' followed by 'FFT') displays the options associated with the FFT.

```
WINDOW: Rectangular Hanning . . . 1

POINTS: 1024 512 256 CURSOR. . . 2
RESULT TO:
    CH1 2 3 4 5 6 7 8. . . . 3

HORIZ SCALE: Linear Log . . . . 4

VERT SCALE: Linear Log . . . . 5

Hz MEASUREMENT: Harmonic Rel. . . 6

<<FOURIER TRANSFORM MENU>>
```

Fig. 5.4.4 Fourier Transform options.

The options available using this menu are as follows:-

The number of points analyzed by the FFT is selected from this menu.

With 1024, 512 or 256 points the FFT will use every point, every 2nd point and every 4th point of the source trace respectively. The FFT will calculate the frequency spectrum faster when using the smaller number of points. However, it should be noted that using 512 or 256 points will reduce the frequency resolution and the maximum frequency detectable in the result.

The following formulae give the frequency range for any number of points analyzed.

$$\text{minimum frequency displayed} = \frac{1}{\text{time duration of trace}}$$

$$\text{max. frequency displayed} = \frac{\text{Number of points analysed}}{2 \times \text{time duration of trace}}$$

Alternatively, if CURSOR is selected then only those points between the time datum and the cursor will be used in the transform. This is useful for selecting a part of the waveform to be analyzed.

NOTE:- If the number of points bounded by these cursors is not exactly 1024, 512 or 256 points then the trace will be padded out symmetrically to the next highest of these values. This padding is done by adding additional points of the same value as those at the cursors.

One of two windowing functions is applied to the waveform prior to perform the FFT. The RECTANGULAR window should be used when analyzing transients or bursts of frequency. The HANNING window should be used with continuous waveforms as it reduces the effects of discontinuity at the edges of the trace.

The frequency spectrum produced by the FFT can be chosen to give linear or logarithmic scaling in the frequency and/or voltage axes.

The final option on the FFT menu selects the format of the cursor measurements on a frequency spectrum produced by an FFT. The Waveform Processor will always display the frequency and voltage at the cursor when a frequency spectrum is selected. In addition, one of two other measurements can be shown. If REL (relative) is selected the difference in frequency between the time datum and the cursor is displayed.

```
CH1: 4.5v  250HzRel  500Hz
```

Alternatively, if HARMONIC is selected the ratio of frequencies at the time datum and the cursor is calculated. Clearly this mode is used for measuring harmonic relationships between peaks in the frequency spectrum.

```
CH1: 4.5v    x2    500Hz
```

The Fourier transform is performed on the trace selected by the cursor by pressing the 'FFT' key. The resulting frequency spectrum displayed on the trace selected from CH1, CH2, CH3, CH4, CH5, CH6, CH7 and CH8.

The modified trace i.e. the one that has a FFT applied to it may be overwritten almost immediately by a fresh acquisition unless the selected trace is held or further acquisitions are prevented e.g. the instrument is in single shot mode and the trace stored or no triggers are provided.

Trace Arithmetic

Trace arithmetic performed using the waveform processor is a more generalized version of that available via the 2608 Special Functions Menu. It has a scaling factor (x1, x.5, x.2 and x.1) that is applied after a multiplication has been performed. Trace arithmetic can be performed as part of the programmable sequence.

```
CH1 2 3 4 5 6 7 8 . . . . 1

ADD Subtract Multiply . . . . . 2

CH1 2 3 4 5 6 7 8 . . . . 3
RESULT TO:
CH1 2 3 4 5 6 7 8 . . . . 4

SCALE: x1 x.5 x.2 x.1 . . . . . 5

<<TRACE ARITHMETIC MENU>>
```

Fig . 5.4.5 Trace Arithmetic set-up.

Pressing the 'MATH MENU' key ('F' followed by 'MATH') displays the trace arithmetic menu.

This menu is used to select the source traces, the destination trace and the arithmetic operation to be performed. Selections are made in the same manner as any of the menus available on the 2608, by using the numeric keys or the datum movement keys.

The arithmetic operation is actioned by a single press of the 'MATH' key when in trace mode. Trace arithmetic performed in this way has the advantage of being easily repeatable and, as it is regarded as a post-storage function, it can be used in combination with 'CAPTURE AND REPEAT'.

Restore

'RESTORE' cancels the last post storage function on the currently selected trace. The previous trace is re-displayed. 'RESTORE' cannot undo functions prior to the last post storage function. Neither can it restore a trace if another trace has been selected or if the cursors are no longer displayed.

Waveform Measurements

For the functions in this section the waveform processor will continuously calculate the results until either another waveform measurement is selected or 'INITIALISE' is pressed.

The measurements are made on the trace selected by the cursors, between the time datum and the cursor. If the cursors are not displayed then measurements will be made on the last trace selected across the entire trace, and the voltage datum is assumed to be at the center of the screen.

Rise Time and Rise Time Percentage

The cursor and time datum should be positioned at the 0% and 100% points of the waveform. The waveform processor calculates the rise/fall time either between the 10 and 90% points of the waveform or between percentage points selected by the user. The first press of 'RISETIME' will display the current setting, i.e. either 10/90% or the user selected values. Further presses will alternate between these two selections.

The user selected percentages are entered by pressing 'SET %' ('F' followed by 'RISETIME'). The message

ENTER RISE/FALL%: 00/00%

is displayed. The two percentages are entered by pressing the appropriate numeric keys on the keypad or front panel of the 2608. For example pressing '1','5','8' and '5' gives

ENTER RISE/FALL%: 15/85%

After the two numbers have been entered the rise time measurement is automatically selected using these percentages.

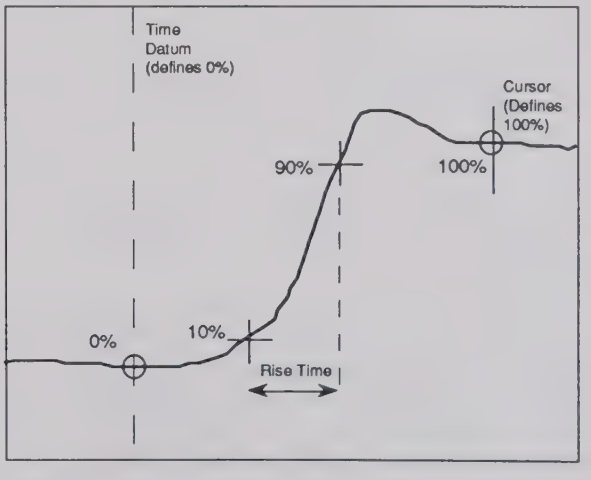


Fig. 5.4.6 Rise Time Measurement

Preshoot and Overshoot

The cursor and time datum should be placed at the 0% and 100% points of the waveform. The waveform processor calculates the overshoot as a percentage of the voltage difference between the 0% and 100% points.

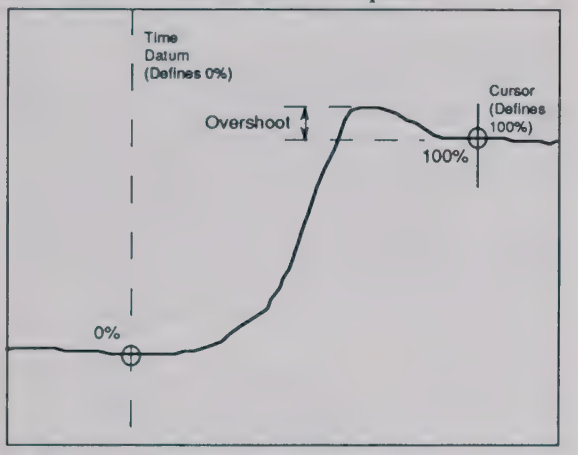


Fig. 5.4.7 Overshoot Measurement

Pulse Width

The waveform processor measures the time between the 50% points of a pulse. The time datum and cursor must be located on either side of the pulse to be measured. Positive or negative pulses can be measured in this way.

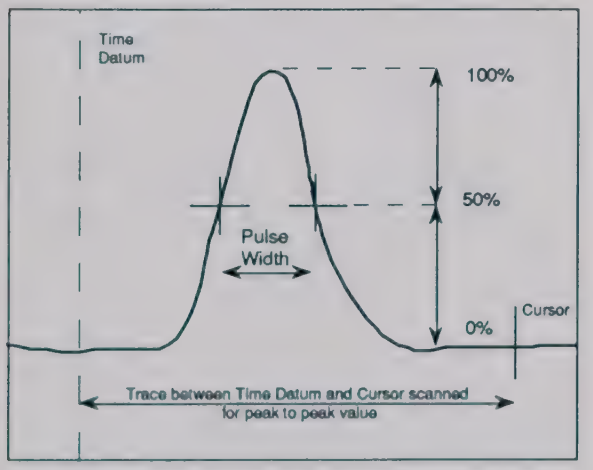


Figure 5.4.8 Pulse Width Measurement.

The first pulse encountered is measured and if the leading edge of the pulse is noisy at the 50% level, the noise may be taken as a pulse and be measured rather than the pulse of interest.

Frequency

The waveform processor will display the frequency, period and duty cycle of the selected trace.

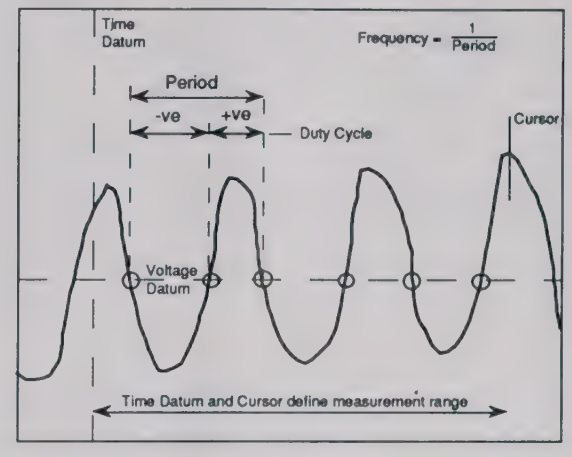


Fig. 5.4.9 Frequency, Period and Duty Cycle Measurement

The voltage datum sets the zero crossing voltage. If the voltage datum is outside the waveform excursion, the mean of the trace between the time datum and the cursor is calculated and is used to define the zero level. If the cursor is not displayed, the results are calculated for the entire waveform taking the center of the screen as the position of the voltage datum.

The cursor and time datum must enclose at least three zero crossings (One complete cycle) or a warning 'TRACE INVALID' will be displayed.

The period is the inverse of the frequency calculated above.

The duty cycle is the ratio of mark or space at the time datum to whole pulse period expressed as a percentage.

Max/Min

The display reads the maximum positive point and minimum negative point of the waveform between the cursor and the time datum. Voltages are measured with respect to voltage datum. If no cursors are displayed the Max/Min points of the entire trace are calculated with respect to the center of the screen.

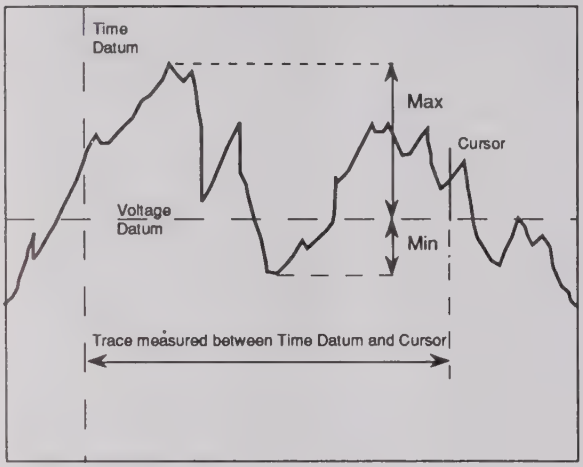


Fig. 5.4.10 Max–Min Measurement

Pk/Pk

The display reads the peak to peak voltage difference between the most positive and negative points of the trace between the cursor and time datum. If no cursors are displayed the Pk/Pk value of the entire trace is calculated.

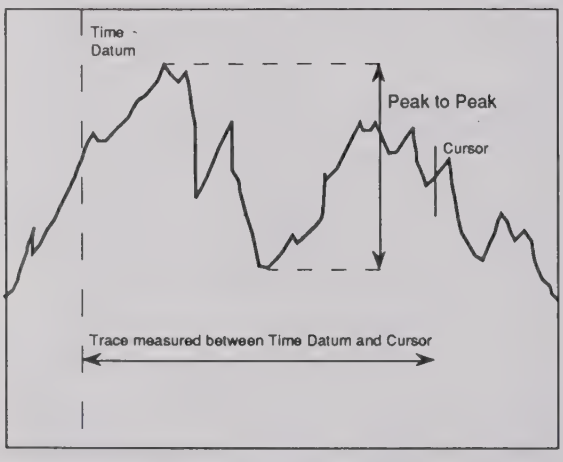


Fig. 5.4.11 Peak to Peak Measurement

RMS

This option calculates and displays two values:

RMS - the RMS voltage with respect to the voltage datum.

AC - the RMS voltage with respect to the mean of trace.

Both the values are calculated on the selected trace on the waveform bounded by the cursor and the time datum. If no cursors are displayed, the RMS voltages of the entire trace are calculated with respect to the center of the screen.

Area

Calculates the area under the curve bounded by the trace, cursor, voltage datum and time datum. If no cursors are displayed, the area will be that bounded by the left and right edges of the screen and the center of the screen.

The waveform processor assumes that if the trace goes below the horizontal datum, as in the example shown in Fig. 5.4.12, the area is negative.

Areas A B and C are added algebraically and the result displayed.

If Area B is greater than Area A+C the result is a negative area. The result is in Vs (Volts-seconds) or similar units. If an area calculation is performed on an integrated trace, the result will be in Vs^2 or similar units.

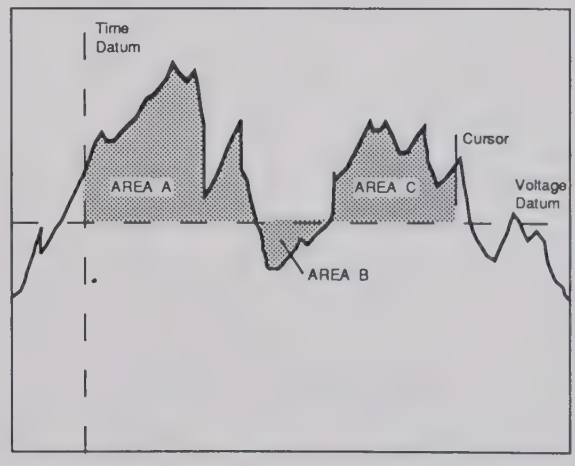


Figure 5.4.12 Definition of Area under curve.

dB and Percentage Measurement

The waveform processor can measure voltage ratios in dB, dBV (dB wrt 1V) and as a percentage. The modes are labeled as follows:

STANDARD UNITS, VOLTS, SECONDS

LOG SCALE, dB wrt REF

LOG SCALE, dB wrt 1V

PERCENTAGE SCALE wrt REF

The 'dB/%' key is used to select which mode is used. The first press will display the current setting, repeated presses cycle through the modes available.

The 'SET REF' key (F followed by 'dB/%') is used to set the reference voltage (Vref) used in calculating dB and percentage results. The first press will display the current value of the reference voltage. A second press of F followed by 'dB/%' will set the reference voltage to the current voltage difference between the cursor and the voltage datum. Attempting to set a reference voltage of 0V will result in the error message

CANNOT SET REFERENCE, 0V

Measurements are calculated according to the following formulae:-

$$dB = 20 \times \log\left(\frac{V}{Vref}\right) \qquad dBV = 20 \times \log(V)$$

$$\text{percentage} = 100 \times \frac{V}{Vref}$$

Print

If the 2608 is fitted with an internal plotter the waveform processor can produce a printed copy of the alphanumeric measurement line displayed at the bottom of the screen along with the current time and date.

For example

CH3: 1.56 mV 3.92mS 16:45:10

03/01/88

This measurement printout facility operates in two modes.

Pressing 'PRINT ON' once will list the current measurement line along with the current time and date.

In the second mode the printing process is automatic. If 'PRINT ON' is pressed twice in succession the measurement line will be printed every time the measurement type is changed. For example, if the current measurement is RMS when 'PRINT ON' is pressed twice, the current RMS measurement will be printed. If 'MAX/MIN' is then selected on the keypad the maximum and minimum values of the waveform are printed.

Note that only the first measurement made by the waveform processor is printed when the measurement type is changed.

In addition any 'CAPTURE' performed while the measurement printout is enabled will be printed by the waveform processor.

Pressing 'PRINT OFF' turns off this continuous printout mode.

Plot

Plots the currently displayed traces or menu on the selected plotter.

Refer to section 3.7 for details of how to select the internal plotter.

Option Functions Menu

The options function shown below is selected by and is used for memory management tasks.

```
SELECT TRACE
   CH1 2 [3] 4 5 6 7 8 ALL  .  .  1

SAVE  CH3 TO MEMORY 18   .  .  .  2

RECALL MEMORY 18 TO  CH3 .  .  .  3

SELECTED  17 02/15/88 CH2 .  .  .  ↑
MEMORY:  [18 02/15/88 CH3]
          19 02/15/88 CH4 .  .  .  ↓

AUTO CAPTURE & SAVE: [OFF] On  .  .  6

MEMORY SIZE: [50x1K] 5x10K  .  .  .  7

CLEAR MEMORY 18 .  .  .  .  .  .  8
      <<REFERENCE WAVEFORMS>>
```

Fig 5.4.13 Reference Memory options Menu

This menu allows the user to access the reference memories in the Waveform Processor Interface module.

Select Trace

Button 1 selects the trace to be saved or recalled to or from the memory module.

If ALL is selected, all the displayed traces i.e. the channels that are turned on will be saved or recalled.

Save To Memory

Pressing button 2 causes the selected trace to be saved to the memory number selected. If ALL traces are selected the memory number is the first one used, subsequent traces are placed sequentially in the next memories. e.g. For the menu shown in figure XX if all 8 traces are displayed, CH1 will be stored in memory 18, CH2 in 19, up to CH8 in memory 25.

The word 'saving' will appear briefly on the menu display. Upon completion the selected memory display line will increment, as will all other reference memory indicators on the menu.

Recall Memory

Button 3 recalls a previously stored memory to the selected trace.

If ALL traces are selected the required number of memories are recalled to use fill all the displayed traces. e.g. to recall memories 18, 19, 20 and 21 to traces 1, 3, 5 and 7, ensure that channels 1, 3, 5 and 7 and turned on and that channels 2, 4, 6 and 8 are turned off.

The word 'recalling' will appear briefly on the menu display. Upon completion the selected memory display line will increment, as will all other reference memory indicators on the menu. When recalling a 10K reference memory, the current settings of X magnification and X shift are taken into account when transferring the data to the display.

When a trace has been recalled, REF will be shown in the V/div area at the top of the screen.

Selected Memory

This display line shows the current selected memory number that will be used by all other functions on the menu screen. The next available selections are also shown above and below the current line. The selected memory can be altered by scrolling in either direction using button 4 to decrement or button 5 to increment the memory number.

Auto Capture & Save

Pressing button 6 will toggle this menu function to ON. The current state is shown in reverse video flashing. When ON, the function is started by a second press of button 6 while the message 'PRESS AGAIN TO START' is displayed. This causes the following sequence of events to occur, starting at the currently selected reference memory number:

a) Instrument armed.

b) Wait till stored.

c) Transfer selected trace to current reference memory.

d) Increment the selected memory number.

The above sequence is repeated until the upper limit of the available reference memories is used (i.e. 5, 48, 50 or 460). The function is canceled by operating a menu selection.

Memory Size

This allows the user to alternate between the two types of memory configuration, either 50 x 1K or 5 x 10K.

Press button 7 will briefly display the message "PRESS AGAIN", if button 7 is pressed again the configuration will change from current to the alternative selection. The repeated push for operation is a safeguard against accidental usage.

Clear Memory

This allows the user to clear the currently selected memory. Pressing button 8 will briefly display the message "PRESS AGAIN", if button 8 is pressed again the currently selected memory will be cleared and the date stamp on the selected memory display line will show <UNUSED>. The selected memory number will not update. The repeated push for operation is a safeguard against accidental operation.

Save One / Save All

These functions allow selected traces to be transferred to the non-volatile reference memories. Pressing 'SAVE ONE' will transfer the trace selected by the cursor to the current reference memory and increment the reference memory number. Similarly, pressing 'SAVE ALL' will save all displayed traces to consecutive reference memories.

5.4.2. Programmable Sequences

The waveform processor can be programmed to perform a sequence of up to 24 acquisition, post-storage and measurement functions. This sequence can then be executed from the keypad by a single key press.

There are two methods of entering and editing a programmable sequence, either while traces are being manipulated or via a menu where waveform processor functions can be added to or deleted from the sequence.

For example, consider the simple problem of comparing the FFT of a waveform with the FFT of the same waveform after it has been filtered. This can be performed in the following manner using standard waveform processor functions.

1) capture the waveform
2) select cursors on the waveform
3) select the destination of the FFT to be a different trace
4) perform the FFT
5) restore the original waveform
6) select the current trace as the FFT destination
7) perform the FFT

Because the two FFT results appear on top of each other it is best to separate them using POSITION.

8) select position and shift the current trace down
9) select the first FFT result
10) select position and shift the current trace up
11) plot the result

Once the programmable sequence has been entered the sequence can be executed with the press of a single key.

Entering a Sequence Using LEARN

In 'learn mode' the waveform processor will remember waveform processor functions as they are executed. When 'LEARN' (F EDIT) is pressed the message

PRESS LEARN AGAIN TO DELETE

SEQUENCE AND START LEARNING

is displayed. If 'LEARN' is pressed again while this message is displayed the waveform processor will enter 'Learn mode'.

NOTE: Entering learn mode will delete any previous sequence present in the waveform processor. The second press of 'LEARN' is a safeguard against accidental erasure of a sequence.

Facilities are provided for listing the sequence on an internal plotter (Listing a Sequencelater in this section) and for saving the sequence via an IEEE/RS423 interface (see SEQU in section 5.4.3). PLOT can also be used with an internal or external plotter to plot the screen contents when editing the sequence.

While in learn mode the screen will show

LEARN: ENTER SEQUENCE

A sequence of up to 24 functions can now be performed before the programmable sequence store is full. As with normal keypad operation the corresponding functions are performed as the keys are pressed.

NOTE:- Although only 24 functions can be entered, each function may consist of a number of individual key presses. For example, selecting a Y magnification of x4.00 can take up to 60 presses of the 'INC' key. Learn mode will remember only the final state of each function, i.e. that a x4.00 magnification was reached.

Once in learn mode the sequence outlined above is entered by invoking the functions corresponding to each step.

1) press 'CAPTURE'.
2) press 'SELECT TRACE' until the correct trace is selected.
3) press 'FFT MENU' then use the soft keys or datum keys to change the FFT destination. Exit using the MENU/ TRACE or '0' keys.
4) press 'FFT'.
5) press 'RESTORE'.
6) press 'FFT MENU' then use the soft keys or datum keys to change the FFT destination. Exit using the MENU/ TRACE or '0' keys.
7) press 'FFT'.
8) press 'POSITION' then use the v key to shift the trace down by 2 divisions.
9) press 'SELECT TRACE' until the first FFT trace is selected.
10) press 'POSITION' then use the ^ key to shift the trace up by 2 divisions.
11) press 'PLOT'.

To indicate that the sequence is complete press the 'EXIT' key. The message

LEARN: SEQUENCE COMPLETE

message will appear to indicate that the waveform processor is no longer in Learn mode. The sequence is stored and executed as it is entered and will remain in the waveform processor until it is deleted or is replaced with a new sequence. As the programmable sequence memory is battery backed the sequence will be retained even if the waveform processor interface is disconnected from the 2608.

Learn mode can be terminated in a number of ways.

1) pressing the 'EXIT' key as described above.
2) pressing the 'EXECUTE' key terminates the sequence and runs it immediately.
3) pressing the 'S/STEP' key terminates the sequence and starts the single step process.
4) pressing the 'EDIT' key terminates the sequence and enters edit mode.
5) pressing 'LEARN' again terminates the sequence then, once again, gives the option of clearing and entering a new sequence.

If the limit of 24 functions is reached while learning the message

LEARN: SEQUENCE FULL

appears on the display. Any further key presses are executed but are not added to the sequence.

NOTE: There are certain function keys that cannot be included in a programmable sequence. These include all the keys in the 'program' section of the keypad and the 'CAPTURE AND REPEAT' key. The effect of pressing one of these keys when in learn mode is as follows:-

Pressing 'CAPTURE AND REPEAT' will display the message

KEY NOT ALLOWED IN SEQUENCE

for a short time. Pressing 'CAPTURE AND REPEAT' does NOT terminate learn mode.

Pressing 'DELETE', 'PREVIOUS' and 'NEXT' will display

KEY ONLY AVAILABLE IN EDIT MODE

as these functions are used only when editing or single stepping a sequence. Again the waveform processor will remain in learn mode if these keys are pressed.

Pressing 'LEARN', 'EDIT', 'S/STEP' or 'EXECUTE' will terminate learn mode and then start the corresponding programmable sequence function.

NOTE: When entering a sequence front panel keys can be used but are not included in the sequence.

NOTE: 'INITIALISE' will restore the waveform processor to its default state, but it will not erase a programmable sequence.

Executing a Sequence

Once a sequence has been entered it can be executed at any time by pressing the 'EXECUTE' key when traces are displayed on the screen.

If the 2608 is in continuous acquisition mode when 'EXECUTE' is pressed the waveform processor will repeatedly acquire a trace and execute the sequence until 'ABORT' is pressed.

If the 2608 is in stored mode when 'EXECUTE' is pressed the sequence will be executed only once. Note that, unlike the continuous execution described above, no trace is acquired prior to executing the sequence and the sequence will operate on the traces displayed. If it is necessary to acquire new traces before executing the sequence, either, press 'CAPTURE' before pressing 'EXECUTE', or include 'CAPTURE' as the first step of the sequence.

NOTE: Errors that occur during execution DO NOT stop the sequence from running. For example, attempting to perform a filter operation without first selecting a trace produces the message

NO TRACE SELECTED

However this will not stop the sequence from executing. The one exception to this rule is if an attempt is made to move the cursors to a trace that is not displayed (see section 3.7).

Executing a Sequence in Single Step Mode

It is also possible to step through the sequence using 'S/STEP' and 'NEXT' key. In single step mode a description of each function is displayed as it is executed. Once the function is complete execution of the sequence is suspended and the message

PRESS NEXT TO CONTINUE

is displayed until 'NEXT' is pressed.

While in single step mode it is not possible to step backwards. Neither is it possible to insert new steps or delete existing steps from the sequence.

Changes such as these can be made only in edit mode. However a limited amount of editing can be performed on the current step. Details on when this applies are given in the Editing While Single Stepping section.

To continue executing the sequence from the current step at the normal speed press 'EXECUTE'. The waveform processor will no longer wait for 'NEXT' to be pressed between sequence steps.

To abort the single step process press 'ABORT.

When the execution of a sequence is complete (either as a result of pressing 'EXECUTE' or having single stepped through the entire sequence) the message

EXECUTION COMPLETE

appears on the screen for a short time.

Editing While Single Stepping

A certain amount of editing can be performed while single stepping. If the current step contains parameters, such as the cursor position in the following line

7_CURSOR: 3.57 xDIV

The left and right cursor keys can be used to adjust the cursor position to the required value.

7_CURSOR: 6.29 xDIV

This facility is used for making alterations to cursors positions, trace selection, y-magnifications, TV lines, filtering, averaging and enveloping factors, cursor modes and scaling.

Capture and Re-Execute

Execution and single stepping are regarded as a post-storage functions.

Therefore, if the last post-storage function was 'EXECUTE' and 'CAPTURE AND REPEAT' is pressed, then the waveform processor will perform an acquisition and re-execute the current sequence. Similarly, if the last function was 'S/STEP' and 'CAPTURE AND REPEAT' is pressed, a new trace is acquired and the sequence is re-executed in single step mode.

Editing a Sequence

While it is possible to enter sequences using only learn mode it is also possible to modify the current sequence. 'Edit mode' allows insertion and deletion of waveform processor functions, modification of existing sequence steps, control over the measurement scroll option and the ability to produce a listing of the sequence.

When the 'EDIT' key is pressed the screen is cleared of traces and up to 14 lines of the current sequence are displayed. Also displayed is the message

Press LEARN to clear sequence

If LEARN is pressed at this point all steps in the current sequence are deleted and a new sequence can be entered. The ability to clear the current sequence is only available before any other key is pressed while editing.

Once a key is pressed the sequence clear option is replaced with a menu option for enabling the measurement scrolling option.

measurement scroll OFF ON . . 1

Measurement scrolling allows several waveform measurements to be displayed on the screen at one time (see later in this section). It is toggled between ON and OFF at any time using the '1' key.

While editing each function is listed along with a number giving its position in the sequence.

1_CAPTURE

2 INVERT

3 INTEGRATE

4 MAX/MIN

The function currently being edited is indicated by the '_' symbol to the right of the step number. Subsequent or previous steps can be reached using the 'NEXT' and 'PREVIOUS' keys. For example, pressing 'NEXT' twice would produce the following display.

1 CAPTURE

2 INVERT

3_INTEGRATE

4 MAX/MIN

The 'DELETE' key is used to remove a step from the sequence. Pressing 'DELETE' produces

1 CAPTURE

2 INVERT

3_MAX/MIN

A new function can be inserted after the current function by pressing the corresponding key. Pressing 'FFT' produces

1 CAPTURE

2 INVERT

3 MAX/MIN

4_FFT

If no sequence is present when in edit mode because the user deleted all the steps in the sequence, the message

NEW SEQUENCE

appears on the screen.

There are a number of ways of leaving edit mode. Pressing '0' on the keypad returns to trace mode. Pressing 'EXECUTE' returns to trace display and immediately begins executing the current sequence. Similarly, pressing 'S/STEP' returns to trace mode and immediately begins single stepping the current sequence. Pressing 'EXIT' will also return to trace display but will also give the option of listing the sequence on an internal plotter if one is fitted (see below, Listing a Sequence).

Listing a Sequence

If an internal plotter is fitted and is selected, pressing 'EXIT' displays the message

Press PRINT ON to list and exit

Pressing 'PRINT ON' will list the sequence on the internal plotter. If any other key is pressed no action is taken and traces are re-displayed. For details on how to select an internal plotter consult section 3.7.

Alternatively pressing 'PLOT' while editing will produce a copy of the programmable sequence on an internal or external plotter. However this will only list the steps displayed.

Entering a Sequence in Edit Mode

The use of edit mode is not confined to modifying sequences entered using LEARN. Sequences can be created in edit mode as an alternative to using LEARN. Entering sequences this way is the ability to insert and delete steps and modify existing ones at will. However it is not possible to see the effect the sequence has on traces until it is executed.

To create a step in edit mode press the same sequence of keys that would be needed to perform the function under normal waveform processor operation. In many cases waveform processor functions are selected with a single key press, e.g. 'CAPTURE', 'AREA', 'OVERSHOOT', 'PLOT' etc.

These can be entered into a sequence simply by pressing the corresponding key. Repeatedly pressing such a key will result in multiple steps with the same function. For example, pressing 'CAPTURE' three times starting with an empty sequence will give

1 CAPTURE

2 CAPTURE

3_CAPTURE

Clearly, when executed, this sequence will perform three acquisitions.

There are several waveform processor functions that have options or parameters associated with them, for example. 'SET AVERAGE' (OFF, 2, 4, ...), 'FILTER' (OFF, 1, 2, 3, 4, 5, 6), 'CURSOR MODE' (V wrt voltage datum, V wrt voltage at time datum, T to last crossing point) etc. As with normal keypad operation, repeated presses of the key corresponding to these functions will cycle through the options available. For example, pressing 'SET AVERAGE' for the first time will give

4_AVERAGING OFF

a further presses will produce

4_AVERAGE 2 TRACES

4_AVERAGE 4 TRACES

4_AVERAGE 8 TRACES

up to

4_AVERAGE 1024 TRACES

Note that only one programmable sequence step is produced, no matter how many times 'SET AVERAGE' is pressed. Only the average factor associated with 'SET AVERAGE' is changed.

As a further example, 'FILTER' works in a similar way to 'SET AVERAGE' with successive presses producing

5_FILTERING OFF

5_FILTER 1

5_FILTER 2

5_FILTER 3

.

up to

5_FILTER 6

YMAG uses a combination of the 'YMAG' key and the 'INC' and 'DEC' keys to produce a program step. Pressing 'YMAG' will produce the following step in the sequence

6_YMAG x 1.000

The 'INC' and 'DEC' keys can now be used to change the magnification that will be applied. For example, repeatedly pressing 'INC' produces

6_YMAG x 1.062

6_YMAG x 1.125

6_YMAG x 1.187

6_YMAG x 1.250

up to

6_YMAG x 4.000

Note that it is necessary to press 'YMAG' before using the 'INC' and 'DEC' keys in order to indicate that they are being used to change magnification as opposed to changing TV line. Failure to do so will produce the message

PRESS YMAG OR TVLINE FIRST

The programmable sequence supports movement of the CURSOR, the TIME and VOLTAGE DATUM and the traces. Pressing either of the CURSOR movement keys will produce a line of the form

9_CURSOR: 3.57 xDIV

The left and right cursor keys are then used to select the required position, e.g.

9_CURSOR: 6.29 xDIV

When this line is executed the cursor will be placed 6.29 divisions from the start of the trace.

Similarly, pressing DATUM will produce a line of the form

10_DATUM: 4.0xDIV 2.70yDIV

which can then be adjusted using the <, >, ^ and v keys to give the required values. Pressing DATUM again will switch between this format and

10_DATUM: TO CURSOR POSITION

which, when executed, will act in an identical fashion to pressing DATUM twice when traces are displayed, i.e. it will set the voltage datum and time datum to the current cursor position. Pressing POSITION gives a similar line to pressing DATUM.

10_POSITION: 7.5xDIV -1.5yDIV

The X and Y shift values can again be changed using the <, >, ^ and v keys. When the sequence is executed this line will cause the trace to shift 7.5 divisions horizontally and -1.5 divisions vertically.

'SELECT TRACE' can be used in a sequence to move the cursors to a particular trace or to turn the cursors off. Pressing 'SELECT TRACE' will cycle through

11_CURSORS TO CH1

11_CURSORS TO CH2

11_CURSORS TO CH3

11_CURSORS TO CH4

11_CURSORS TO CH5

11_CURSORS TO CH6

11_CURSORS TO CH7

11_CURSORS TO CH8

11_CURSORS OFF

NOTE:- If, while executing a sequence, an attempt is made to move the cursors to a trace that is not displayed, the sequence is aborted with the message

CHANNEL NOT ON

This is necessary because it is impossible to predict which traces will be ON when the sequence is executed. This is the only time execution of a programmable sequence is aborted.

FFT and MATH Steps in a Sequence

To enter an FFT or MATH operation into a sequence press the corresponding key.

For each FFT or MATH step included in a sequence there is a copy of the FFT MENU or MATH MENU. These menus can be edited by pressing F FFT or F MATH when an FFT or MATH operation is the current step. The corresponding menu will be displayed and can be modified to give the required function. Pressing '0' or '9' will return to the editing menu. Each FFT/MATH step in the sequence can have a different set-up and therefore a different action.

For example the set-up for

12_MATH may be CH1 + CH2 to CH3

and for

18_MATH CH1 * CH3 to CH7

When executing FFT or MATH steps the waveform processor will use the settings placed in the menu when entering each step.

Measurement Scrolling

Because of the speed at which a programmable sequence is executed it can be difficult to examine the results as they are displayed on the screen.

This effect is most obvious when a sequence contains two consecutive measurement functions.

1 CAPTURE

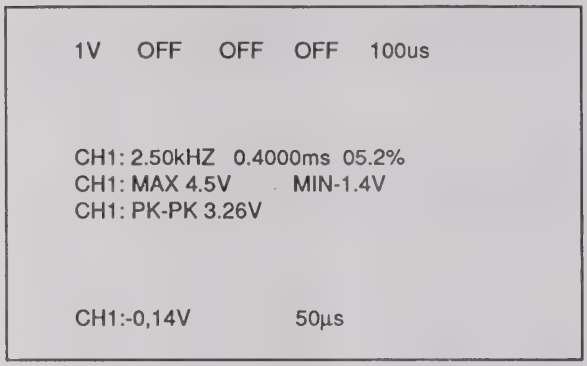
2 FREQUENCY

3 MAX/MIN

4 PK/PK

5 VOLTS, TIME MODE

Having executed step 2 the frequency measurements will be displayed but are immediately replaced by the MAX/MIN measurements. Using scroll allows successive measurements to be retained on the display. 'Measurement scrolling' can be turned on and off by pressing '1' while editing the sequence. For example, having selected scrolling, if the sequence above is executed the following display would be produced.



Up to eight lines can be displayed before the first measurement is scrolled off the top of the list.

Wait

In addition the WAIT function can be included in a sequence to suspend execution at any point and freeze the display for examination. At this point the message

PRESS NEXT TO CONTINUE

will be displayed on the screen and will remain until 'NEXT' is pressed. 'WAIT' can also be used in a sequence to suspend execution while manual changes need to be made to the 2608 front panel.

5.4.3 Waveform Processor GPIB/RS423 Command summary

The 260 Waveform Processor adds a range of additional commands to the GPIB/RS423 command set of the standard 2608.

A summary of these commands is given below followed by a section containing detailed descriptions of the commands. Both these sections are given in alphabetical order.

Command	Parameter	Function	Type
ACRMS		RMS value about mean of waveform	I
ADEST	trace	Select destination of trace arithmetic	A,I
AOPND	trace	Select second source for trace arithmetic	A,I
AREA		Area under trace	I
AROP	SUM SUB MULT	Select trace arithmetic operation	A,I
ASCALE	1,2,5,10	Select scaling after trace multiply	A,I
ASRC	trace	Select first source for trace arithmetic	A,I
CALC		Perform trace arithmetic	D
CAPTURE		Arm the 1600 to acquire traces	D
CMODE	NORMAL RELDAT RELTRC	Select cursor measurement mode	A,I
CSCALE	NORMAL DB DBV PER	Select cursor scaling	A,I
DUTY		Duty cycle about voltage datum	I
FFT		Perform a Fourier Transform	D
FFTHSC	LIN LOG	Select FFT horizontal scaling	A,I
FFTMEAS	HARM REL	Select FFT frequency measurement	A,I
FFTPTS	1024 512 256 128 CURSOR	FFT points sampled	A,I
FFTTRC	trace	FFT destination trace	A,I
FFTVSC	LIN LOG	FFT vertical scaling	A,I
FFTWIND	RECT HANN	FFT window selection	A,I
FILTER	1,2,3,4,5,6	Filter trace with one of 6 filters	D
FREQ		Frequency about voltage datum	I
HELLOWP		Waveform processor hello message	I
HPS	number	Horizontal post storage shift	A,I
INIT		Initialise keypad	
INTG		Integrate about voltage datum	D
INVPS		Invert trace after storage	D
LIM	CONT HALT OFF	Test Limits	A,I
LIMST	PASS FAIL	Limit status	I
LOWLIM		Save lower limit	D
MAX		Maximum measured from datum	I
MEAN		Average voltage of trace	I
MIN		Minimum measured from datum	I
OVER		Overshoot percentage	I
PEAK		Peak to peak time	I
PERIOD		Period at datum level	I
PRESH		Preshoot percentage	I
PRINT	ON OFF	Enable/Disable results printout	A,I
REFM		Reference Memory transfer	A,I
RISE		Rise time at 10,90% points	I
RMHS		Reference memory horizontal scaling	A,I

RMVS		Reference memory vertical scaling	A,I
RMS		RMS value measured from datum	I
RMTYPE		Reference memory type	A,I
RESTORE (VPS)		Recover from last function Vertical position post storage (see section 5.3)	D
RISEPER	0-100	Rise/fall variable bounds	A,I
RUNSEQ		Execute programmable sequence	D
SAVEONE		Save current trace to reference memory	D
SAVEALL		Save all traces to reference memories	D
SEQU		Programmable sequence transfer	A,I
SETAVG	*OFF,2,4,8, 16,32,64, 128,256,512, 1024	Set averaging factor	A,I
SETENV	OFF,2,4,8, 16,32,64, 128,256,CONT	Set enveloping factor	A,I
SETREF		Set dB and %age reference voltage	A,I
TVMODE	625 525 OFF	TV mode triggering	A,I
UPLIM		Save upper limit	D
VTMODE		Select volts, time measurement	D
WIDTH		Pulse width at 50% points	I
YCAL	CAL UNCAL	Vertical calibration	A,I
YMAG	number	Post storage Y mag	A,I
YSCALE	number	Vertical scaling factor	I

5.4.4 Waveform Processor GPIB Command Detail

The IEEE/RS423 commands are designed to allow access to the functions of the 260 waveform processor, they operate in the same way as pressing the buttons on the keypad. All the measurement functions which return a value (i.e. those which are interrogative only) work on data bracketed between the time datum and the cursor.

The cursor must be selected for the trace on which the measurements are being made (see the CSRTR command in the main operating manual). If the cursors are switched off then measurements will be made on the last selected trace between the first and last data point taking the center of the screen as the voltage datum. With the exception of rise and fall measurements, it does not matter which way round the cursor and time datum are positioned for selecting the measurement window.

Note that if the selection fails, for example in the case of the DUTY command if no zero crossings are found, then the function will return a value of -1, as well as generating a service request of 100.

The convention used in this manual is the voltage datum is displayed as a horizontal line on the screen and is the reference for voltage measurements, and the time datum is displayed as a vertical line on the screen and is the reference for time measurements.

If required, the measurements of duty cycle, frequency, and period can be made about the center of the trace. This is done by first using either the MEAN or MAX/MIN functions to determine the center point, and then setting the voltage datum to this level. For example to measure the frequency of trace 1A:

CSRTR = 1A	Select trace 1A
DATMH = 0	set datum to left of screen
CRSHP = 10	set cursor to right of screen
MEAN	request mean of trace 1A input mean value
DATMV =	mean value set datum to center of trace
FREQ	request frequency of trace 1A input result

Details of Functions

Each command is listed below in alphabetical order together with a detailed explanation of its function. Some example uses of the command are also shown.

Function: **RMS value about mean of waveform**

Type: Interrogative

Syntax: ACRMS

Explanation: The RMS value of the selected waveform between the time datum and cursor is measured by first calculating the mean of the waveform. The difference between this level and the waveform for each point, is then squared and the average of these values is then square rooted and returned.

Example: ACRMS
'ACRMS = 2.34' (2608 response)
(RMS voltage is 2.34 Volts)

Note: If the peak value of the trace between the time datum and cursor lies outside the range of the A/D converter, i.e. if it is off screen, the routine will return a service request 103 as well as a result using the maximum allowable value.

See also: RMS

Function: **Select destination of trace arithmetic**

Type: Assertive, Interrogative

Syntax: ADEST
ADEST = [trace]

Explanation: Select the destination trace for trace arithmetic operations. The results of future trace arithmetic operations will be stored in this trace.

Example: ADEST
'ADEST = CH8 (2608 response)
(Arithmetic result to Channel 8 trace)

ADEST = CH2

See also: AOPND, AROP, ASCALE, ASRC, CALC

Function: **Select second source trace for trace arithmetic**

Type: Assertive, Interrogative

Syntax: AOPND
AOPND = [trace]

Explanation: This command selects the trace arithmetic operand.

Example: AOPND
'AOPND = CH4' (2608 response)
(Arithmetic operand is Channel 4)

AOPND = CH3

See also: ADEST, AROP, ASCALE, ASRC, CALC

Function: **Select arithmetic operation**

Type: Assertive, Interrogative

Syntax: AROP
AROP = [SUM] or [SUB] or [MULT]

Explanation: Select the arithmetic operation (ADD, SUB or MULT) performed by the waveform processor trace arithmetic.

Example: AROP
'AROP = SUB' (2608 response)
(Current operation is subtract)

AROP = MULT

See also: ADEST, AOPND, ASCALE, ASRC, CALC

Function: **Select Trace Multiplication Scaling**

Type: Assertive, Interrogative

Syntax: ASCALE
ASCALE = [1] or [2] or [5] or [10]

Explanation: After a multiplication operation has been performed by the waveform processor trace arithmetic the resulting trace is scaled down by 1, 2, 5 or 10 times. NOTE:- this scaling is only applied when AROP = MULT

Example: ASCALE
'ASCALE = 10' (2608 response)
(Current scaling is 1/10)

ASCALE = 5

See also: ADEST, AOPND, AROP, ASRC, CALC

Function: **Select trace arithmetic source**

Type: Assertive, Interrogative

Syntax: ASRC
ASRC = [trace]

Explanation: Select the first source for trace arithmetic operations.

Example: ASRC
'ASRC = CH4' (2608 response)
(Arithmetic source is channel 4)

ASRC = CH3

See also: ADEST, AOPND, AROP, ASCALE, CALC

Function: **Area under trace**

Type: Interrogative

Syntax: AREA

Explanation: The area under the selected waveform between the time datum and cursor by summing the voltage differences between the trace and the voltage datum. The result is then rescaled into units of Volts Seconds.

Example: AREA
'AREA = 2.34E-6' (2608 response)
(RMS voltage is 2.34uVs)

Note: If the peak value of the trace between the time datum and cursor lies outside the range of the A/D converter, i.e. if it is off screen, the routine will return a service request 103 as well as a result of zero.

See also: INTG

Function: **Perform trace arithmetic**

Type: Direct

Syntax: CALC

Explanation: The waveform processor will the arithmetic function (AROP) using the two source traces (ASRC and AOPND) and places the result in the destination trace (ADEST).

Example: CALC

See also: ADEST, AOPND, AROP, ASCALE, ASRC

Function: **Perform a Waveform Processor acquisition**

Type: Direct

Syntax: CAPTURE

Explanation: Arms the 2608 to acquire traces. Note that this function acts in the same manner as pressing 'CAPTURE' on the keypad. CAPTURE differs from the ARM command available on the 2608 as it will take into account the current settings of SETAVG and/or SETENV. For example, if SETAVG has been set to 128 beforehand the performing a CAPTURE will perform 128 acquisitions in order to calculate their average.

Example: CAPTURE

See also: SETAVG, SETENV

Function: **Select cursor measurement mode**

Type: Assertive, Interrogative

Syntax: CMODE
CMODE=[NORMAL], [RELDAT] or[RELTRC]

Explanation: Selects one of the three voltage and time measurement modes.NORMAL, RELDAT and RELTRC correspond to 'V wrt VOLTAGE DATUM', 'V wrt V AT TIME DATUM' and 'T TO LAST CROSSING POINT' respectively. For more details on the measurements made in these modes see the 'Time and Voltage Measurement' section of this manual.

Example: CMODE
'CMODE = RELTRC' (2608 response)
(Current cursor mode is T TO LAST CROSSING POINT')

CMODE = RELDAT

See also: CSCALE, SETREF, VTMODE

Function: **Select cursor vertical scaling**

Type: Assertive, Interrogative

Syntax: CSCALE
CSCALE = [NORMAL] or [DB] or [DBV] or [PER]

Explanation: Selects the vertical scaling of measurements to be volts (NORMAL), dB wrt the reference voltage (DB), dB wrt 1V (DBV) or percentage wrt the reference voltage (PER).

Example: CSCALE
'CSCALE = PER' (2608 response)
(Percentage scaling is being used for cursor measurements)

CSCALE = DBV

See also: CMODE, SETREF, VTMODE

Function: **Duty cycle about voltage datum**

Type: Interrogative

Syntax: DUTY

Explanation: The duty cycle of a waveform is the ratio of the time the waveform is positive to the period of the waveform. this function notes the positions where the waveform crosses the voltage datum and so calculates the duty cycle as a percentage of the period.

Examples: DUTY
'DUTY = 39.1' (2608 response)

(Duty cycle is 39.1%)

Note: If no cross over points are found then service request 100 will be generated and the value -1 will be returned.

See also: PERIOD

Function: **Perform a Fourier transform**

Type: Direct

Syntax: FFT

Explanation: Performs a fast Fourier transform on the currently selected trace. For more details see the description of the FFT function in the Post-Storage section of this handbook.

Example: FFT

See also: FFTHSC, FFTMEAS, FFTPTS, FFTTRC, FFTVSC, FFTWIND

Function: **Select FFT horizontal scaling**

Type: Assertive, Interrogative

Syntax: FFTHSC
FFTHSC = [LIN] or [LOG]

Explanation: Select the format of the frequency spectrum produced by an FFT.

Example: FFTHSC
'FFTHSC = LIN' (2608 response)
(Linear output selected)

FFTHSC = LOG

See also: FFT, FFTMEAS, FFTPTS, FFTTRC, FFTVSC, FFTWIND

Function: **Select the frequency measurement mode for FFT traces**

Type: Assertive, Interrogative

Syntax: FFTMEAS
FFTMEAS = [HARM] or [REL]

Explanation: Selects between harmonic or relative frequency measurement on an FFT trace. Harmonic measurement displays the ratio of the frequency at the time datum to the frequency at the cursor. Relative measurement displays the difference in frequency between the cursor and the time datum.

Example: FFTMEAS
'FFTMEAS = REL' (2608 response)
(Relative measurement selected)

FFTMEAS = HARM

See also: FFT, FFTHSC, FFTPTS, FFTTRC, FFTVSC, FFTWIND

Function: **Select number of points sampled by Fourier transform**

Type: Assertive, Interrogative

Syntax: FFTPTS
FFTPTS = [256] or [512] or [1024] or [CURSOR]

Explanation: Selects the number of points that are considered from the selected trace in order to perform an FFT. If 512 points are selected then every second point of a 1024 point trace is used. Similarly every fourth point for FFTPTS=256. If CURSOR is selected then only those points between the cursor and voltage datum are used.

Examples: FFTPTS
'FFTPTS = USER' (2608 response)
(Points between cursors selected)

FFTPTS = 512

See also: FFT, FFTHSC, FFTMEAS, FFTTRC, FFTVSC, FFTWIND

Function: **Select destination of Fourier transform**

Type: Assertive, Interrogative

Syntax: FFTTRC
FFTTRC = [trace]

Explanation: Selects the destination of the frequency spectrum produced by the Fourier transform.

Example: FFTTRC
'FFTTRC = CH1' (2608 response)
(Frequency spectrum will be sent to Channel 1)

FFTTRC = CH2

See also: FFT, FFTHSC, FFTMEAS, FFTPTS, FFTVSC, FFTWIND

Function: **Select FFT vertical scaling**

Type: Assertive, Interrogative

Syntax: FFTVSC
FFTVSC = [LIN] or [LOG]

Explanation: Select the amplitude scaling performed by an FFT process.

Example: FFTVSC
'FFTVSC = LIN' (2608 response)
(Linear output selected)

FFTVSC = LOG

See also: FFT, FFTHSC, FFTMEAS, FFTPTS, FFTTRC, FFTWIND

Function: **Select Fourier Transform window function**

Type: Assertive, Interrogative

Syntax: FFTWIND
FFTWIND = [RECT] or [HANN]

Explanation: This command selects which type of window function is applied to a trace prior to performing a Fourier transform. Either a rectangular or Hanning window can be used.

Examples: FFTWIND
'FFTWIND = RECT' (2608 response)
(Rectangular window selected)

FFTWIND = HANN

See also: FFT, FFTHSC, FFTMEAS, FFTPTS, FFTTRC, FFTVSC

Function: **Filter waveform**

Type: Direct

Syntax: FILTER = [1] or [2] or [3] or [4] or [5] or [6]

Explanation: The selected waveform is filtered by one of six digital low pass filters. The effective cutoff frequency of each filter is determined by the timebase setting.

Example: FILTER = 3

Note: When the filtering operation is completed a service request 74 will be generated. A copy of the data is taken so the RESTORE command will recover the original waveform. If the trace is not stored or held a service request 100 will be generated and no action will be taken.

Function: **Frequency about voltage datum**

Type: Interrogative

Syntax: FREQ

Explanation: The frequency of the selected waveform between the time datum and cursor is measured by looking for points at which the waveform crosses the voltage datum, from these points the period and hence the frequency of the waveform is calculated.

Example: 'FREQ = 15.1E+3' (2608 response)
(Frequency = 15.1kHz)

Note: If no cross-over points are found then service request 100 will be generated and the value -1 will be returned.

See also: PERIOD

Function: **Waveform processor hello message**

Type: Interrogative

Syntax: HELLOWP

Explanation: This command is used to check the keypad version and memory type.

Example: HELLOWP
'HELLOWP = WP260/205 version X.XX'
(2608 response)

See also: HELLO in section 5.3.

Function: **Horizontal post storage shift**

Type: Assertive, Interrogative

Syntax: HPS
HPS = number

Explanation: After data has been stored or is held, an individual trace can be moved horizontally. This is done by rotating the data through the store, so there will be a discontinuity at the point where the first and last acquisition are placed next to one another. The number in the command is the shift in divisions relative to its initial position, and so it can lie in the range +10.23 to -10.23. Positive numbers indicate a shift to the right, and negative numbers a move to the left. The value read back when the command is used interrogatively is the total shift from the captured position, and so the trace can be restored to its original position by applying equal and opposite shift.

Example: HPS
'HPS = -3.9' (2608 response)
(Currently selected trace is shifted 3.9 divs to the left)

HPS = 2.3

Note: Since the position before the shift is remembered the RESTORE command will reset the trace to its previous position, i.e. HPS = 0. If the shift required is outside the allowable range a service request 103 will be generated. When the shifting is completed a service request 74 will be generated.

See also: VPS, SHFT in section 5.3

Function: **Initialise keypad**

Type: Direct

Syntax: INIT

Explanation: This command is equivalent to pressing the Initialise button on the keypad, and it resets the internal variables to their default settings.

Example: INIT

Note: When the initialization is complete a service request 74 will be generated.

Function: **Integrate trace**

Type: Direct

Syntax: INTG

Explanation: The selected trace is integrated with respect to time, the voltage zero is taken to be the voltage datum. The result is automatically scaled and the scaling factor is retained so that the cursors read correctly. This factor can be read out using the YSCALE command.

Example: INTG

Note: When the integration is completed a service request 74 will be generated. A copy of the data is taken so the RESTORE command will recover the previous trace. If the trace is not stored or held a service request 100 will be generated and no action will be taken.

See also: YSCALE

Function: **Invert trace post storage**

Type: Direct

Syntax: INVPS

Explanation: This command inverts the trace about the voltage datum and is equivalent to pressing the invert button on the keypad. A record of the original trace is taken and so the RESTORE command will recover the last action of this function. The sign of YSCALE is changed to record the fact that the trace has been inverted.

Example: INVPS

Note: When the invert is complete a service request 74 will be generated. If the trace is not stored or held a service request 100 will be generated and no action will be taken.

Function: **Limit test mode**

Type: Assertive

Syntax: LIM
LIM = [OFF] or [CONT] or [HALT]

Explanation: The limit testing works by comparing the trace in one channel with reference trace 1.

The reference trace memory 1 holds both the upper and lower limits by using alternate sample points. For example if the test waveform in trace 1A must lie between a data value of 50 and 110, then reference trace 1 should contain the data:

50, 110, 50, 110, 50, 110 .....

The limit waveform can be transferred to and from the computer (see the sending and receiving stores paragraphs of section 5.2). If required, the upper and lower limits can be set from the corresponding sweep (see LOWLIM and UPLIM).

The channel to be tested is selected using the cursors. The section of the waveform on which the limit test is performed is defined by the time datum and cursor.

The LIM command is used to select the operating mode for limits testing. There are two possible modes:

Continuous: Data is continuously acquired and tested. The result is displayed or read out as PASS or FAIL.

Halt: Data is acquired and tested. When the test is failed acquisition stops.

The result of the test can be read out using the LIMST command.

Example: LIM
'LIM = HALT' (2608 response)
(Acquisition will stop if selected trace falls outside limit)

LIM = CONT

See also: LIMST, LOWLIM, UPLIM

Function: **Limit test status**

Type: Interrogative

Syntax: LIMST

Explanation: This command is used to read the result of the limit test. The response will be PASS if the trace under test is within the limits defined by the limit waveform and the time datum and cursor, and it will be FAIL if any data point lies outside these limits. If the limit test mode is HALT the response will be PASS until a trace has failed and been stored, when the response will be FAIL.

Example: LIMST
'LIMST = PASS' (2608 response)
(trace is within limit)

Note: If no limits testing has been selected using the LIM command a service request 100 will be generated.

See also: LIM, LOWLIM, UPLIM

Function: **Save lower limit**

Type: Direct

Syntax: LOWLIM

Explanation: This command is equivalent to pressing the Save Lower Limit button on the keypad and is used to set up the lower limit for limits testing. This is held in reference trace 1. LOWLIM will save the selected trace in the correct form for limits testing.

Example: LOWLIM

Note: When the transfer is complete a service request 74 will be generated.

See also: UPLIM, LIM, LIMST, HMOD

Function: **Maximum measured from datum**

Type: Interrogative

Syntax: MAX

Explanation: This command returns the maximum value of the trace in volts measured from the voltage datum. If the section of the waveform selected by the time datum and cursor is below the voltage datum then the result will be negative.

Example: MAX
'MAX = 54E-2' (2608 response)
(Maximum value is 54 millivolts)

Note: If the peak value of the trace between the time datum and cursor lies outside the range of the A/D converter, i.e., if it is off screen, the routine will return a service request 103 as well as a result using the maximum allowable value.

Function: **Mean of trace**

Type: Interrogative

Syntax: MEAN

Explanation: This command returns the mean value of the trace between the time datum and cursor in divisions. It can be used to find the center of an ac waveform prior to measuring duty cycle, period or frequency.

Example: MEAN
'MEAN = 2.4' (2608 response)

(Mean value is 2.4)

Note: If the peak value of the trace between the time datum and cursor lies outside the range of the A/D converter, i.e., if it is off screen, the routine will return a service request 103 as well as a result using the maximum allowable value.

See also: MAX

Function: **Minimum relative to datum**

Type: Interrogative

Syntax: MIN

Explanation: This command returns the minimum value of the waveform in volts measured from the voltage datum. If the section of the waveform selected by the time datum and cursor is above the voltage datum then the result will be negative.

Example: MIN
'MIN = 55.4E-3' (2608 response)

(Maximum value is 55.4m Volts)

Note: If the peak value of the trace between the time datum and cursor lies outside the range of the A/D converter, i.e., if it is off screen, the routine will return a service request 103 as well as a result using the maximum allowable value.

See also: MAX

Function: **Enable and disable measurement scrolling**

Type: Assertive, Interrogative

Syntax: MSCROLL
MSCROLL = [ON] or [OFF]

Explanation: Enables the scrolling up the screen of successive cursor measurements. Note this mode only operates during the execution of a programmable sequence.

Example:

MSCROLL
'MSCROLL = OFF' (2608 response)
(Measurement scrolling is disabled)

MSCROLL = ON

See also: PRINT

Function: **Overshoot**

Type: Interrogative

Syntax: OVER

Explanation: The overshoot of an edge is measured between the time datum and the cursor. The 0% and 100% points are taken as the points where the time datum and the cursor cross the waveform. The overshoot is the ratio of the maximum point between the time datum and cursor and the voltage difference between the time datum and cursor expressed as a percentage.

There are a number of different possible measurements which can be made, depending on the relative positions of the time datum and cursor:

Condition	Measurement
1: Rising edge, datum to left of cursor	Overshoot
2: Falling edge, datum to left of cursor	Undershoot

Example: OVER
OVER = 21.9' (2608 response)
(Overshoot is 21.9%)

Note: If the peak value of the waveform between the time datum and cursor lies outside the range of A/D converter, i.e., if it is off screen, the routine will return a service request 103 and return a result of 100%.

See also: RISE, MAX, MIN, PEAK

Function: **Period at voltage datum**

Type: Interrogative

Syntax: PERIOD

Explanation: The period of the selected waveform between the time datum and cursor is measured by looking for points at which the waveform crosses the voltage datum, and then calculating the period allowing for incomplete cycles.

Example: PERIOD
'PERIOD = 53.4E-6' (2608 response)
(Period is 53.4µsec)

Note: If no cross-over points are found then service request 100 will be generated and the value -1 will be returned.

See also: FREQ

Function: **Preshoot**

Type: Interrogative

Syntax: PRESH

Explanation: The overshoot of an edge is measured between the time datum and the cursor. The 0% and 100% points are taken as the points where the time datum and the cursor cross the waveform. The overshoot is the ratio of the minimum point between the time datum and cursor and the voltage difference between the time datum and cursor expressed as a percentage.

Example: PRESH
'PRESH=18.2' (2608 response)
(Preshoot is 18.2%)

Note: If the peak value of the waveform between the time datum and cursor lies outside the range of A/D converter, i.e., if it is off screen, the routine will return a service request 103 and return a result of 100%.

See also: OVER

Function: **Enable or disable measurement line printing**

Type: Assertive, Interrogative

Syntax: PRINT
PRINT = [ON] or [OFF]

Explanation: This command allows the user to enable or disable the measurement line on plots from the 2608.

Example: PRINT = ON
PRINT
'PRINT = OFF' (2608 response)
(Measurement printout is disabled)

See also: MSCROLL

Function: **Transfer to reference memory**

Type: Assertive, Interrogative

Syntax: REFM*
REFM (number)
REFM (number) = [datafield], [TRC1A], [TRC2A], [TRC3A], [TRC4A], [TRC5A], [TRC6A], [TRC7A] ,[TRC8A]

Explanation: The command takes one basic interrogative form which allows the transfer of a reference memory to the host computer. The number of the reference memory de-

pends upon the current mode. The two modes are 50 x 1K or 5 x 10K reference memories. Consequently the valid ranges are REFM(1-50) or REFM(1-5). The REFM* form of this command will transfer all reference memories in the current mode.

The two basic assertive forms will again operate with any valid reference memory number for the current mode.

The format of the data field is dependent on the specified block length. If BLL = 0 then this will consist of 1024 numbers in the specified base followed by <cr> <lf> with EOI on the <lf>. If BLL is non zero then the data field will consist of a number of blocks, each separated by a <cr> <lf> with EOI on the last <lf> if asserted.

Examples: REFM*
REFM5
REFM17
REFM23 = TRC3A

See also: EOI, BL, BLL, NB, WIND, in section 5.3.

Note: Service request 103 will be generated if the number is out of range. Service request 102 will be generated for a syntax error.

Function: **Transfer from reference trace**

Type: Assertive, Interrogative

Syntax: TRC1A=REFM1...REFM*
TRC2A=REFM1...REFM*
TRC1A = [data field], [reference memory number],

Explanation: The operation of this command will supersede the same command existing in the IEEE/RS423 option. The command takes three interrogative forms (REFT*, REFT1, REFT2) these will transfer the data from either both or one reference trace to the host computer. Each reference trace store consists of 1024 data samples, the first being for the left-hand edge of the screen and the next successive one for the position further right, each time.

There are three assertive forms of the command which will operate with either reference trace. These allow bulk transfer of data from the host to a reference trace, transfer of a reference memory to a reference trace and transfer of a trace to a reference memory.

The format of the data field is dependent on the specified block length. If BLL = 0 then this will consist of 1024 numbers in the specified base followed by <cr> <lf> with EOI on the <lf>. If BLL is non zero then the data field will consist of a number of blocks each separated by a <cr> <lf> with EOI on the last <lf> if asserted.

The range of the reference memory numbers is dependent on the current modes. The two modes are 50 or 1K or 50 x 10K reference memories. Consequently the two valid ranges are REFM(1-50) or REFM(1-5).

Examples: TRC1A=REFM22
TRC*A=REFM1

See also: EOI, BL, BLL, NB, WIND in section 5.3.

Note: Service request 103 will be generated if the number is out of range. Service request 102 will be generated for a syntax error.

Function: **Rise time of a waveform**

Type: Interrogative

Syntax: RISE

Explanation: The rise time of the waveform is measured between the percentage points as set by the RISEPER command. The 0% point is defined by the point where the time datum crosses the trace, and the 100% point is defined by the value at the cursor position. Working from the time datum, the routine will accept the first points at which the waveform crosses the lower of the two percentage levels. The result is the time from this point to the time at which the waveform crosses the higher percentage value. If the 0% is greater than the 100% level then the fall time is calculated in the same way as the rise time.

Example: RISE
'RISE = 832E-9' (2608 response)
(Rise/Fall time is 832 nsec)
RISE
'RISE = 532E-6' (2608 response)
(Rise/Fall time is 532 µsec)

See Also: RISEPER

Function: **Select bounds for rise/fall measurement**

Type: Assertive, Interrogative

Syntax: RISEPER
RISEPER = [number]

Explanation: The percentage bounds used in the calculation of the rise/fall value are set using this command. The default values set at power up are 10%,90%.

Example: RISEPER = 20,80
RISEPER
'RISEPER = 15,85' (2608 response)
(Current bounds are 15% and 85%)

See also: RISE

Function: **Reference memory horizontal scaling**

Type: Assertive, Interrogative

Syntax: RM (number) HS
RM*HS
RM (Number)HS = [timebase range]

Explanation: The command takes one basic interrogative form which gives the timebase value that was valid when the trace was stored. The number of the reference memory depends upon the current mode. Consequently the valid ranges are (1-50) or (1-5). The RM*HS form of this command will give all the associated timebase values for each reference memory in the current mode. The assertive form of this command allows a particular reference memory's timebase value to be altered. The timebase range is 50µs to 200s per division in 1, 2, 5 steps.

Examples: RM3HS
RM*HS
RM7HS = 100E-6

NOTE: Service request 102 will be generated for a syntax error.

Function: **Reference memory vertical setting**

Type: Assertive, Interrogative

Syntax: RM(number)VS
RM*VS
RM(number)VS = [vertical setting]

Explanation: The command takes one basic interrogative form which gives the vertical settings that were valid when the trace was stored. The number of the reference memory depends upon the current mode. Consequently the valid ranges are (1-50) or (1-5). The RM*VS form of this command will give all the associated vertical settings for each reference memory in the current mode. The assertive form of this command allows a particular reference memory's vertical settings to be altered.

The vertical setting takes the form of:-

– Trace Inverted
> Variable, uncalibrated
~ AC coupled

Trace inverted. variable and ac coupled are optional. The vertical range is 10mV to 10V per division in 1,2,5 steps.

Example: RM23VS
RM*VS
RM43VS = -10E-2~
(set to inverted 100mV DIV ac coupled.)

Function: **RMS value about voltage datum**

Type: Interrogative

Syntax: RMS

Explanation: The RMS value of the selected waveform between the time datum and cursor is measured taking the voltage datum as the zero level. The difference between this level and the waveform, for each point is squared and the average of these values is then square rooted and returned as the result.

Example: RMS
'RMS = 12.34' (2608 response)
(RMS Voltage is 12.34 Volts)

Note: If the peak value of the trace between the time datum and cursor lies outside the range of the A/D converter, i.e., if it is off screen the routine will return a service request 103 as well as a result using the maximum allowable value.

See also: ACRMS

Function: **Reference memory type**

Type: Assertive, Interrogative

Syntax: RMTYPE
RMTYPE = [5] or [50]

Explanation: This command takes one basic interrogative form which gives the current reference memory type. There are two configurations of reference memories, either 50 x 1K or 5 x 10K. The reference memory type refers to the number of memories i.e. 5 or 50 memories. The assertive form of this command allows the reference memory configuration to be altered between types.

Example: RMTYPE = 50
RMTYPE
RMTYPE = 5' (2608 response)

Note: Service request 103 will be generated for numbers out of range.

Function: **Restore original trace**

Type: Direct

Syntax: RESTORE

Explanation: This command is equivalent to pressing the Restore button on the keypad. It returns the trace to the condition it was in before the last waveform manipulation. The functions which can be recovered in this way are:

HPS, INT, INVPS, YMAG, FILTER

Example: RESTORE

Function: **Execute the current programmable sequence**

Type: Direct

Syntax: RUNSEQ

Explanation: The programmable sequence currently stored in the waveform processor is executed.

Example: RUNSEQ

See also: SEQU

Function: **Save trace to reference memory**

Type: Direct

Syntax: SAVEONE

Explanation: The trace currently selected by the cursor is saved to the current reference memory. The reference memory pointer is then moved on to the next reference memory.

Example: SAVEONE

See also: SAVEALL, REFM*

Function: **Save displayed traces to reference memories**

Type: Direct

Syntax: SAVEALL

Explanation: All currently displayed traces are saved in consecutive reference memories. The reference memory pointer is then moved on to the next reference memory.

Example: SAVEALL

See also: SAVEONE, REFM*

Function: **Save or recall a programmable sequence**

Type: Assertive, Interrogative

Syntax: SEQU = n,b1,b2,b3,b4,...,bm
SEQU

Explanation: When used interrogatively the 2608 will send a sequence of numbers that represent the current set of programmable sequence steps. Sequences of this type can be returned to the 2608 using the assertive format of this command. NOTE:- a programmable sequence saved in this way is a string of numbers similar to a machine setup, NOT a textual representation of the programmable sequence. No attempt should be made to send a sequence that has been created other than by the 260 Waveform Processor. SEQU is intended only as a means of saving and recalling programmable sequences.

See also: RUNSEQ

Function: **Set averaging factor**

Type: Assertive, Interrogative

Syntax: SETAVG
SETAVG = [number]
where number is one of 2, 4, 8, 16, 32, 64, 128, 256, 512 or 1024

Explanation: Used to set or return the number of acquisitions CAPTURE will perform in order to create an averaged trace.

Example: SETAVG = 128
SETAVG
'SETAVG = 8' (2608 response)
(Averaging factor is 8 traces)

See also: CAPTURE, SETENV

Function: **Set enveloping factor**

Type: Assertive, Interrogative

Syntax: SETENV
SETENV = [number]
where number is one of 2, 4, 8, 16, 32, 64, 128, 256 or CONT

Explanation: Used to set or return the number of acquisitions CAPTURE will perform in order to compile an envelope of the maximum and minimum values.

Example: SETENV = 256
SETENV
'SETENV = 16' (2608 response)
(Enveloping factor is 16 traces)

See also: CAPTURE, SETAVG

Function: **Set reference voltage**

Type: Assertive, Interrogative

Syntax: SETREF
SETREF = [number]

Explanation: Sets the reference voltage for dB and percentage measurements.
For more details of these and other measurement modes see the 'Waveform Measurements' section of this manual.

Example: SETREF=1E-3 sets the reference voltage to 1 millivolt
SETREF
'SETREF = 0.287' (2608 response)
(Reference voltage is 287 millivolts)

NOTE:- if the 2608 is uncalibrated then values are given or interpreted in terms of divisions.

See also: CSCALE

Function: **Select TV triggering**

Type: Assertive, Interrogative

Syntax: TVMODE
TVMODE = [625], [525] or [OFF]

Explanation: This command sets up the triggering correctly for capturing TV lines. It is equivalent to pressing the TVMODE button on the keypad. Once TVMODE has been set to 625 or 525 then setting TVMODE to OFF will return the trigger system to its state before the TVMODE command was issued. For this command to function correctly the trigger level must be set so that the instrument triggers on the TV sync pulses.

To select different TV line use the PH+ and PH– commands to phase slip the triggering. See section 5.4.1.

Example: TVMODE = 625
TVMODE
'TVMODE = OFF' (2608 response)
(TV trigger mode not selected)

See also: PH+, PH–

Function: **Save upper limit**

Type: Direct

Syntax: UPLIM

Explanation: This command is equivalent to pressing the Save Upper Limit button on the keypad and is used to set up the upper limit for limits testing. The upper limit is held in the reference trace 1 UPLIM will save the selected trace in the correct form for limits testing.

Example: UPLIM

Note: When the transfer is complete a service request 74 will be generated.

See also: LOWLIM, LIM, LIMST, HMOD

Function: **Select standard measurement mode**

Type: Direct

Syntax: VTMODE

Explanation: Resets the cursor measurement mode to 'V wrt VOLTAGE DATUM' and the cursor scaling to 'NORMAL'. These are the default measurement types selected when the 2608 is switched on.

Example: VTMODE

See also: CMODE, CSCALE

Function: **Pulse width at 50%**

Type: Interrogative

Syntax: WIDTH

Explanation: The pulse width of the selected waveformbetween the time datum and cursor is measured by first performing a max/min function on the waveform. The 50% level is then calculated and the time between the two points at which the waveform crosses this level is measured.

Example: WIDTH
'WIDTH = 57.6E-6' (2608 response)
(Pulse width is 57.6µsec)

Note: If no cross over points are found then service request 100 will be generated and the value -1 will be returned.

Function: **Vertical calibration**

Type: Interrogative

Syntax: YCAL

Explanation: This command is used to determine if a trace is calibrated or uncalibrated. The two possible responses which can be returned are CAL and UNCAL. If the trace was captured using the variable gain or if the trace has been magnified after storage the response will be UNCAL, otherwise the response will be CAL. If the trace is CAL then the results measurements will be in Volts, and if the trace is UNCAL the results will be in divisions.

Example: YCAL
'YCAL = CAL' (2608 response)
(Trace is calibrated)

See also: YMAG, VG*

Function: **Post Storage Y magnification**

Type: Assertive, Interrogative

Syntax: YMAG
YMAG = number

Explanation: After data has been stored or held, an individual trace can be expanded or reduced vertically about the voltage datum. The maximum allowable range for magnification is 0.062 to 4.0 and this is achieved in 63 steps so the resolution of the magnification factor is 0.06. A copy of the original trace is retained when each magnification is performed, so all magnification factors are relative to the previous trace and not the currently displayed one. For example, requesting a YMAG of 2 followed by a YMAG of 3 on a trace which was 1 division peak to peak. The RESTORE command will reset the trace to its original magnification, i.e., YMAG = 1. The total magnification can be read out using the YSCALE command.

Example: YMAG = 2
YMAG
'YMAG = 0.5' (2608 response)
(Currently selected trace is reduced by a factor of 2)

Note: If a magnification is requested outside the allowable range a service request 103 will be generated. If the trace is not stored or held a service request 100 will be generated and no action will be taken.

Function: **Vertical Scaling factor**

Type: Interrogative

Syntax: YSCALE

Explanation: This command is used to read out the overall scaling of the trace after various waveform processing functions have been performed. It is the number by which the current trace must be multiplied to return to the original. If no functions have been performed then YSCALE = 1, so this can be used to check whether the results of the measurement are in divisions or Volts. The functions which affect YSCALE are INTG, YMAG and INVPS.

Example: YSCALE
'YSCALE = 1.76' (2608 response)
(Trace has been reduced by 1.76)

See also: INTG, YMAG, YCAL, INVPS

6. Alphabetical Summary of Controls

This section contains a list of all the front panel controls arranged in alphabetical order. Each control has a brief summary of its function.

Abort (46) Used to stop the plot sequence or restore local control from the GPIB bus.

AC As part of **AC/Com/DC, AC** removes DC components from signals of between 4Hz and 7MHz. As part of **hf/rej/AC/DC** it sets AC coupling for the trigger signal, which may be between 10Hz and 7MHz.

AC/Com/DC (35) Controls the type of coupling between the instrument and the input signal. **AC** is used to remove DC components from signals of between 4Hz and 7MHz. **DC** couples the input signal directly to the instrument, so that all frequency components of the signal up to 7MHz will be displayed. **Com** internally disconnects the inputs from the instrument; a common reference signal is displayed instead.

Add (4) Displays the sum (or difference if one channel is inverted) of channel pairs. The original traces disappear and the resultant trace is displayed as a new trace. There are separate **Add** button for channels 1&2, 3&4, 5&6 and 7&8. When Add is selected the appropriate Add light is illuminated.

Armed (11) Illuminates after **S/shot** is pressed; it will stay lit until either a valid trigger has been received or the **Run** button has been pressed.

Auto Part of **Auto/Norm.** When Auto is selected, and no valid triggers have been received for 0.05s, an artificial trigger is generated and a capture is initiated.

Auto Setup (48) Will attempt to arrange the display so that two to five complete cycles appear, with the amplitude set so that the height of the trace is between two to five divisions. Also, it selects **Auto** trigger to ensure that the screen is frequently updated and a trace will be visible. If the frequency of the input signal is less than 20Hz, this function may not operate correctly.

Auto/Norm (17) Selects the trigger mode. **Norm** means that valid triggers must be received to initiate captures. **Auto** triggering is the same as **Norm** except that if no valid trigger has been received for some time, an artificial trigger will be generated: the instrument will generate its own triggers if no valid trigger has been received for 0.05s (i.e. 20Hz is the lower limit).

CH1/CH3/CH5/CH7 (13) Steps through the trigger sources.

CH2/CH4/CH6/CH8 (14) Steps through the trigger sources.

CH1 (47) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 1. It can also be a trigger source if selected using **CH1/CH3/CH5/CH7.**

CH2 (44) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 2. It can also be a trigger source if selected using **CH2/CH4/CH6/CH8.**

CH3 (40) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 3. It can also be a trigger source if selected using **CH1/CH3/CH5/CH7.**

CH4 (36) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 4. It can also be a trigger source if selected using **CH2/CH4/CH6/CH8.**

CH5 (33) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 1. It can also be a trigger source if selected using **CH1/CH3/CH5/CH7.**

CH6 (30) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 6. It can also be a trigger source if selected using **CH2/CH4/CH6/CH8.**

CH7 (28) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 7. It can also be a trigger source if selected using **CH1/CH3/CH5/CH7.**

CH8 (27) One of the eight isolated channel input sockets, this one being for the connection of signals up to ± 500V peak to channel 8. It can also be a trigger source if selected using **CH2/CH4/CH6/CH8.**

Com Part of **AC/Com/DC, Com** disconnects the input signal from the instrument and connects the input amplifier to Common.

CURSOR (7) Controls the movement of the cursor.

DATUM (3) & (5) These two buttons control the movement of the time and voltage datum lines.

DC As part of **AC/Com/DC, DC** couples the input signal directly to the instrument so that all frequency components from DC to 7MHz are displayed. As part of **hf/rej/DC/AC** it couples triggers from DC to 7MHz to the instrument.

Delay (23) This control varies the amount of Pre or Delay trigger depending on the status of the Pre/Dly switch (22)

Display (37) Selects the Display Controls menu.

EXT TRIGGER socket for the connection of external triggers of up to ±200V peak, located on the rear panel. Input impedance 100KΩ

Ext External trigger source.

hf Part of **hf/rej/AC/DC** (16)

hf/rej/AC/DC (16) selects trigger coupling. The **hf rej** (high frequency reject) option is a 15kHz low-pass filter. Any coupling may be used with any source except **Line** where the coupling is not selectable.

Hold (21) Freezes the relevant channel display until it is pressed again. The hold light is illuminated to indicate that a particular trace is held.

Hold All (43) Freezes all the trace displays until it is pressed again. The hold all light is illuminated when all the traces are held.

Inv Part of **Off/On/Inv** (34); this option is used to invert the display of a channel's trace - i.e. to negate it so that it is displayed upside down.

Level (19) Adjusts the trigger level, which is indicated by two trigger bars on the display.

Line Mains frequency triggers. Input coupling is not selectable with this option.

Master (38) Selects the Master Menu.

Menu/Traces (2) Swaps the display between the last used menu and the trace display.

Norm Part of **Auto/Norm** (17). The instrument will only initiate captures when a valid trigger is received when in **Norm** mode.

Numeric Keys (1) These keys are used in conjunction with the menu system to control the advanced features of the 4060 not normally available directly from the front panel.

Off As part of the **Off/On/Inv** (34), is illuminated if the channel is turned off.

Off/On/Inv (34) Switches the channel **On** or **Off**. If the channel is on its trace can be displayed **Inverted**.

On As part of the **Off/On/Inv** (34), is illuminated if the channel is turned on. The Hold All On light is illuminated when all channels are held, the Plot On light is illuminated when a plot is in progress and the Power On light is illuminated when the instrument is powered up.

Plot (45) Initiates a plot output. The plot On light is illuminated during the plot sequence. Pressing this button a second time aborts the plot.

Post Illuminates when Delay time has been selected using the **Pre/Dly** button (22).

Position (25) Moves all traces horizontally.

Position (32) Moves that channel's trace vertically.

POWER (39) Used to switch the instrument on or off. When the instrument is turned on the Power On light is illuminated.

Pre Illuminates when Pre trigger has been selected using the **Pre/Dly** button (22).

Pre/Dly (22) Selects either Delay or Pre trigger to be varied by the Delay paddle (23).

Refr Part of the **Refr/Roll** button (8), illuminates when refresh mode is selected.

Refr/Roll (8) Used to select either Refresh or Roll display mode. **Refr**eshed mode is the normal oscilloscope mode whereby the trace is plotted from left to right. **Roll** mode is like a chart recorder; the display scrolls from right to left as the trace is acquired.

rej Part of **hf/rej/AC/DC** (16)

Roll Part of the **Refr/Roll** button (8), illuminates when roll mode is selected.

Run (12) Puts the instrument in continuous capture mode; The instrument automatically rearms itself after each acquisition.

Select Trace (6) Places the cursor onto a displayed trace. Each successive press moves the cursor to the next available trace.

Split Screen (41) Selects the split screen/display compression menu.

S/Shot (9) Arms the instrument for a single-shot triggered acquisition sweep (capture). The **Armed** light will be illuminated to show that this button has been pressed.

Stored (15) Illuminates on completion of a single-shot acquisition. It will stay lit until the instrument is rearmed or until **Run** is pressed.

TIME/DIV (24) Controls the sweep rate of the trace. The timebase can be varied from 50µs/Div to 200s/Div in a 1, 2, 5 sequence of values.

Trig'd (20) This is illuminated when the timebase is receiving valid triggers.

Uncal (29) Controlled by the **Variable V/DIV** and numeric buttons. When lit, the coarse setting of the vertical attenuator remains unchanged, but a variable gain is applied to the input signal. When Uncal is selected, the **V/DIV** paddle is used to vary the attenuation throughout the range from 1 to 0.4.

Variable V/DIV (42) Selects the Uncal display to enable the numeric buttons to toggle the relevant channel between Uncal and Cal.

V/DIV (31) Adjusts the vertical sensitivity over discrete calibrated ranges from 10mV/Div to 5V/Div in 1, 2, 5 steps. With a x10 probe the ranges are 100mV/Div to 50V/Div at the probe tip. Input voltages to the instrument **must not exceed ±500V peak.** If the **Uncal** light is on, then this paddle controls the sensitivity over an uncalibrated continuous range of values.

X Mag (26) Used to select the horizontal magnification. The X-Mag light illuminates when X-Mag is selected.

+,-/+,– (18) Selects triggering on positive or negative slopes or within a band.

Appendix 1: Error Messages

There are certain states or operating conditions on the 2608 that are not achievable or mutually exclusive. When the operator tries to select these conditions or when something is wrong, an error message will be displayed near the bottom of the display.

In some cases a message will appear to confirm that an action has occurred.

Brief explanations of when, or under what conditions, these messages occur are given below in alphabetical order of the messages.

**** AUTO SETUP ****
Displayed during Auto Set-up after the Auto Set-up button has been pressed.

AUTO SETUP – aborted/failed
a) Displayed if the Abort button is pressed while the instrument is performing an Auto Set-up.

b) Displayed if the Auto Set-up function was not successfully completed for any reason.

+N NOT AVAILABLE IN ROLL MODE
Displayed if attempting to enter ROLL mode when DIVIDE BY N trigger mode is already selected.

No add in XY mode
Displayed if an attempt is made to turn ADD On when the instrument is in XY mode.

No Cursors In XY Mode
Displayed if an attempt is made to turn the cursors On when the instrument is in XY mode.

OK to shift
Displayed when a requested change in x–magnification has been successfully completed.

Plotting Complete
Displayed after a Color Plot is completed.

Shift when capture complete
Displayed if an attempt is made to apply x–shift when the instrument is in both Pre–trigger and Refresh mode with the traces not Held or Stored.

It indicates that the requested x–shift will occur when the current capture is completed.

Will change Mag. when data ready
Displayed if X–MAG is turned On or Off when the instrument is in both Pre–trigger and Refresh mode with the traces not Held or Stored.

It indicates that the requested change in x–magnification will occur when the necessary data has been acquired.

X–MAG CHANGE NOT ALLOWED
Displayed if an X–MAG change is requested when the instrument is in both pre–trigger and refresh mode with the traces not stored but with one or more traces held (either individually held or ALL held).

Appendix 2: Specification

DISPLAY

CRT: 8 x 10cm rectangular screen .

Graticule: Internal, 8 x 10 divisions with 0.2 sub divisions.

Resolution: Y-T display 256 x 1024 per channel.

X-Y display 256 x 256.

Focus: Soft key controls.

Trace Rotate: Soft key control.

Intensity: Separate soft key controls for Traces, and Alphanumerics.

VERTICAL SYSTEM

Eight identical isolated input channels, CH1, CH2, CH3,CH4, CH5, CH6, CH7 and CH8.

Sensitivity: 10mV/div to 5V/div in 1-2-5 sequence.

Accuracy: ≤ ± 3%, ± 1 LSB (0.4%).

Variable Sensitivity: >2.5:1 range allowing continuous adjustment of sensitivity between ranges.

Input Impedance: 1MΩ ± 2%//35pF input to common, single ended, isolated.

Input Coupling: AC.
DC.
Common: Input is shorted to floating common.

Bandwidth: DC: 0 - 7MHz (-3dB).
AC: 4Hz - 7MHz (-3dB).

Common Mode Rejection Ratio (CMRR):

AC: >80dB @ 60Hz 1kΩ unbal.
DC: >85dB.

Input Protection: ±500V DC or peak AC, to 5kHz or transient, common to chassis ground (mains earth)
±500V DC or peak AC, to 10kHz or transient, input to common of a channel .

HORIZONTAL SYSTEM

Sweep Rate: 22 ranges in 1-2-5 sequence.

50µs/div to 200s/div. (50µs/div only available when either only ODD or only EVEN numbered channels are active).

Accuracy: ±3% of unexpanded time/div.

Expansion: x1, 2, x5, x10, x20, x50, x100, x200 about center of screen with linear dot interpolation.

TRIGGER DELAY

Trigger Delay Range: 2ms/div to 50µs/div: 100ms max.
200ms/div to 5ms/div: 10s max.
200s/div to 500ms/div: 1000s max.
Events: 1 to 16383 trigger events.
Divide by N: N = 2 to 16383.

Resolution: 1% of time/div.

Pre-Trigger: 0.1 to 100% of sweep in 0.1% steps.

TRIGGER SYSTEM

Auto/Normal Mode: In Auto the timebase free runs when insufficient signal (20Hz to 20MHz) is present or when the selected level is outside the range of the input signal.

Source: CH1-8, EXT, Line.

Coupling: AC, DC, ACLP, DCLP (LP bandwidth 15KHz).

Slope: +ve, -ve or band (±0.5 to ±4divs).

Sensitivity:

Internal	DC coupled	<0.3 div DC to 2MHz.
		<0.6 div DC to 7MHz.
	AC coupled	<0.3 div 10Hz to 2MHz.
		<0.6 div 4Hz to 7MHz.
External	DC coupled	<150mV DC to 2MHz.
		<300mV DC to 7MHz.
	AC coupled	<150mV 10Hz to 2MHz.
		<300mV 4Hz to 7MHz.

Range: Internal ± 13 divisions.
External ± 12V.

External Input Impedance: 100KΩ ± 5%//≤ 30pF.

External Input Protection: 250V DC or peak AC.

DISPLAY MODES

Refreshed: Stored data and display updated by triggered sweep. For timebases ≤ 20ms/div refresh operates as repetitive single shot.

Roll: Stored data and display scrolled from right, updated continuously for timebases 200ms/div to 200sec/div. Trigger stops the updating process. For timebases faster than 200ms/div roll operates as repetitive single shot.

Dot Join: Linear analogue dot join.

X-Y: X-Y display is 8 x 8 divisions. Stored data and display are updated by triggered sweep. CH1 is used as the X and the other channels are used as the Y deflection.

Single Trace: CH1 or CH2 or CH3 or CH4 or CH5 or CH6 or CH7 or CH8.

Multi Trace: Any combination of the input channels can be used.

Split Screen: Any combination of the input channels can be displayed compressed to 1/2, 1/4 or 1/8 of normal size, maintaining full 8 bit resolution.

Add: Any of the channel pairs CH1/CH2, CH3/CH4, CH5/CH6 or CH7/CH8 may be independently added.

Invert: Any of the input channels may be independently inverted.

Single Shot: Arms the instrument for a single triggered sweep and freezes the store at the end of the sweep.

Display Trace Hold (All): Freezes the store immediately.

Channel Trace Hold: Freezes individual channel immediately.

ACQUISITION SYSTEM

Record Length: 10K samples per channel.

Maximum Sample Rate: 20 megasamples/sec with only EVEN or only ODD channels active @ 50µs/div.
10 megasamples/sec with any combination of channels active @ 100µs/div.
Reducing with timebase range to 5 samples/sec @ 200s/div.

Vertical Resolution: 8 Bits (1 in 256) 28.57 levels per division.

A-D Conversion Linearity: Less than ± 1/2 LSB error.

ACQUISITION MODES

Normal Mode: Transient and repetitive signal capture. Max transient capture timebase 50µs/div 50ns/sample in only EVEN or only ODD channels active, 100µs/div 100ns/sample with any combination of channels active.

Repetitive Normal Mode: Maximum repetitive capture timebase 100µs/div 100ns/sample with any combination of channels active.

X-Y Mode: Bandwidth as acquisition channel. Acquisition rate dependent on timebase range to a maximum of 20MS/sec.

Peak Detection: (Glitch Capture) Capture of 50ns pulse width when only EVEN or only ODD channels are active otherwise 100ns glitch capture. 100% probability of capture.

MEMORY

Waveform Memory: Eight 1K reference memories are provided for waveform data storage. Any reference memory can be recalled to any display trace. A maximum of eight traces can be displayed. These memories are non-volatile.

Set-Up: 4 control set-ups can be stored. The control set up is retained on power down. These memories are non-volatile.

Retention Time: The memory support is trickle charged and will retain information for 3 months after power down.

ON SCREEN MEASUREMENTS and ALPHANUMERIC DISPLAY

Datum Lines: Horizontal and vertical full screen amplitude time and voltage datums.

Cursor: The measurement cursor can be assigned to a trace and measurements made in time and voltage with respect to the datums.

Cursor Measurement Display: ΔVoltage and ΔTime displayed on screen.

Accuracy: Voltage ≤ ±3% of reading, ± 1 digitizing level.
Time ± 0.1% of unexpanded time/div, or ±0.02% of >x10 expanded time/div.

Resolution: Voltage 0.42% of F.S.D.
Time 0.2% of F.S.D.

Trigger Indication: On screen trigger level and trigger point indication. On trace bright up. Arrow for off screen indication of trigger level.

Alphanumerics: Display on screen to indicate vertical sensitivity, uncal status, compression status and addition status for each channel, timebase speeds and pre-trigger or trigger delays.

MENU SELECTION

Master Menu: Selects menus for fast access to; Status, Trigger setup, Autocal,.Cal/Uncal, Probe gain, Max/min selection, IEEE, RS423, plotter configuration, Instrument setup, and Date and time.

Variable V/Div: Selects menu for setting individual channel variable vertical sensitivity.

Display: Selects menu for focus trace rotate and screen intensities.

Split Screen: Selects menu for setting individual channel trace compression.

Menu/Traces: Alternately switches between trace display and the last menu selection.

AUTO SETUP

Automatically sets the front panel controls to display any applied repetitive input signal for frequencies greater than 20Hz. Trigger and timebase priority is CH1.

I/O OPTIONS

The instrument can be fitted with either an IEEE-488 or a RS423 interface pod.

IEEE-488 I/O (optional pod)

Parallel data interface which permits all the front panel controls except POWER On/Off to be programmed.

RS423 I/O (optional pod)

Serial interface which permits all the front panel controls except POWER On/Off to be programmed and also contains a bi-directional port for the transfer of binary trace data and associated range parameters.

Baud Rate: 110, 300, 600, 1200, 2400, 4800, 9600.

Data Bits: 8.

Parity: None.

Start/Stop: Fixed, one start bit, one stop bit.

Handshake: XON, XOFF.

DIGITAL PLOTTER INTERFACE

The instrument can directly output to suitable HPGL format plotters via the optional RS423 or IEEE interface pods.

Plot Mode: Manual or auto selection to output a stored trace.

Annotation: Range and scaling annotation, graticule, time and date information, cursors and cursor readout can all be included in the plot output.

Color: Colored pens automatically selected when available.

REAL TIME CLOCK

Real time clock maintained by internal battery backup.

ENVIRONMENTAL

Temperature: Operating 0° to +50°C.
Full specification + 15° to +35°C.
Storage -20° to +70°C.

Humidity: Operating IEC 68-2-Ca at 45°C with 95% RH.
Non-operating IEC 68-2-Db cycling 25° C to 45°C with 95% RH, 6 cycles (144 hours).

Vibration: MIL spec 810D. Random frequency vibrations of 5-500Hz at 1g rms for 15 minutes.
IEC 68-2-6 Test Fc. 15 cycles of 1 minute duration 10 to 55Hz at 0.6mm peak to peak displacement in each of the three major axis (4g at 55Hz).

Altitude: Operating 4600m @ 40°C.
Non-operating 15000m.

Safety: Designed for IEC 348 Cat 1 standard.

EMC: 4517/78 IEC TC64 WG4, 2KV spike in or out of line phase and ½ cycle dropout has no effect on instrument.

RFI: Conducted and radiated; to VDE 0871 level A, BS 6527 and US FCC part 15.

MISCELLANEOUS

Calibrator: 1V peak to peak ± 1%, frequency approximately 1kHz calibration signal on front panel.

Ground: Front panel ground reference for use with calibration signal.

POWER REQUIREMENTS

AC Voltage: 100V, 120V, 220V or 240V AC ±10%.

Frequency: 45 to 400Hz.

Power: 200W, 250VA

WEIGHT

21Kg (approx. 46lb)

DIMENSIONS

200mm height x 380mm width x 470mm depth,
(7¾ x 15 x 18½inches) excluding handle.

ACCESSORIES SUPPLIED

Operating Manual.
Line Cord.
8 Fully Insulated Probes Type PB38.

OPTIONS

IEEE Interface Pod.	2600/103A
RS423 Interface Pod.	2600/102
Waveform Processor.	2600/260
Memory Module	2600/205
Color Plotter – Factory fitted option.	

OPTIONAL ACCESSORIES

Rack mounting kit.	04094732
Carrying case.	04101172
Front facia cover.	04101262
Service manual.	04101254
Lemo to BNC convertor. N.B the input is no longer isolated when this convertor is used.	04101261

Appendix 3. Glossary of terms

Alias
A false image caused when the signal is very much faster than the sample rate see section 1.6.2.

An effect that occurs when an analog signal is sampled digitally at a sampling frequency less than twice the signal frequency: a signal is retrieved from the sample information that differs from the original input signal. The retrieved signal the alias has a frequency that corresponds to the harmonics of the high frequency components of the original signal. At frequencies close to the Nyquist frequency the signal can appear to be amplitude modulated.

ANSI
American National Standards Institute.

BSI
British Standards Institute.

CMRR
Common Mode Rejection Ratio. The measure by which the ability of the instrument to ignore signals common to both the hi and lo input terminals is determined. This is given by the following equation;

$$\text{CMMR} = 20 \text{ Log}_{10} \frac{\text{Displayed signal on screen}}{\text{Signal on common}}$$

with the input and common connected to the same point.

CRT
Cathode Ray Tube. The display device in the 2600 DSO.

Data points
The individual samples of the input waveform.

DSO
Digital Storage Oscilloscope.

IEE
Institution of Electrical Engineers. (UK)

IEEE
Institute of Electrical and Electronics Engineers, Inc. (USA)

GPIB
General Purpose Interface Bus; Another more common name for the IEEE–488 interface bus defined by ANSI/IEEE Standard 488–1978.

Nyquist Frequency
Also known as sampling theorem. This states that if an input signal contains no frequency components higher than f, the signal can be captured and displayed without distortion if it is sampled at a rate greater than $2f$. f is referred to as the Nyquist Frequency.

Real Time Sampling
Used for single sweep acquisitions. The signal is sampled so that all the data points are acquired at equal time intervals sequentially from the start to finish of a single sweep.

RS423
Interface standard set by the Electronic Industries Association (EIA). This is normally compatible with RS232 interfaces.

Sample Rate
The rate at which the instrument records the signal levels of the input waveform to produce the data points.

Appendix 4 Discussion on Floating Inputs

INPUTS

Single Ended input

Most oscilloscopes are connected to the circuit under test either directly, through a coax cable or indirectly, through a probe. In either case, the shield of the connecting cable is electrically connected to the outer ring of the oscilloscope's BNC input connector which is grounded via the AC supply ground.

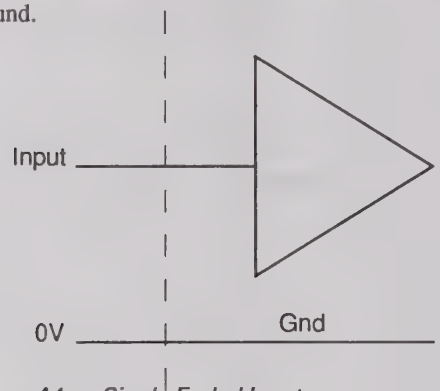


Figure A4a Single Ended Input

This ground is carried through to the circuit under test. Hence, because only the inner terminal of the BNC carries a deliberate signal, the term "single ended" describes this often-used form of connection. This is the situation when the 2608 is used with the Lemo to BNC adaptor, which shorts the signal common to supply ground (instrument chassis), see section 2.6.1

A4

Using this type of input on circuits where the reference point is not necessarily the same as supply ground can cause problems. If the reference point in the circuit is not at the same potential as the supply ground then a current will flow through the scope. While this may not significantly disrupt the oscilloscope's operation, it can have a major effect on the operation of the circuit under test.

Isolated or "Floating" input

Many recorders and X-Y plotters contain isolated inputs, i.e., neither of the two input terminals is directly connected to ground. In these instruments, the terminals are often labeled "+" or "HI" corresponding to the inner terminal of a single ended BNC circuit, and "-" or "LO" or "common", corresponding to the outer ring of a BNC.

In an isolated configuration, however, the outer is not connected directly to the supply ground as it is in a single ended configuration.

On the 2608, the co-axial Lemo type connectors have a central pin for the "HI" or Input, and an inner screen for the "LO" or Common. These are both shielded by the outer metal part of the connector, which is connected to supply ground and the instrument chassis.

The actual amplifier circuit of an isolated input internal to the 2608 is similar to a single ended circuit, and has a relatively high capacitance between supply ground and the common terminal.

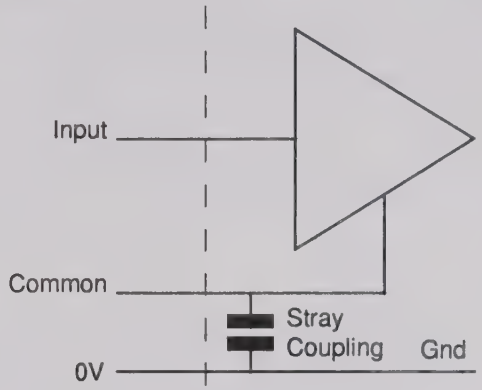


Figure A4b Floating Input

The capacitance coupling the common to supply ground limits the maximum frequency that the input amplifier can be floated at. For a typical capacitance to ground of 200pF the input impedance of the common input is shown in figure A4c.

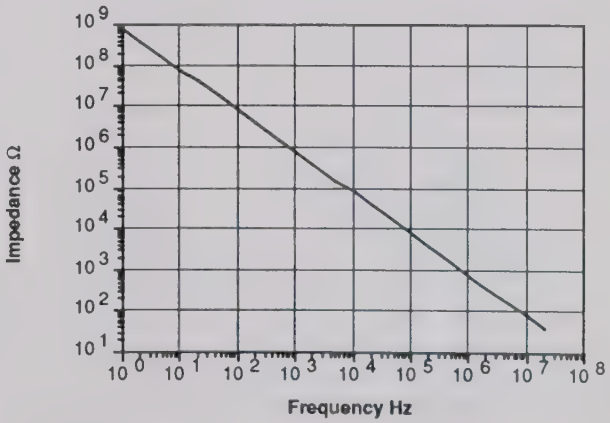


Figure A4c Input Impedance for a capacitance of 200pF

This means that the maximum frequency at which the input can be floated is dependant on the output impedance of the source. The output impedance of the source must be lower than the input impedance of the 2608 at the required frequency.

The capacitance to ground is not the only factor which affects the performance of the input stage. There will also be some cross-over into the input channel from signals which are common to both the signal input and the common. This is specified as the common mode rejection ratio.

The common mode rejection ratio is the ratio of the signal present on both the input and the common, to the displayed signal on the instrument. For the 2608 this is 80dB at 60Hz. This means that the ratio is 1:10000 of the displayed part of the common signal to the common signal.

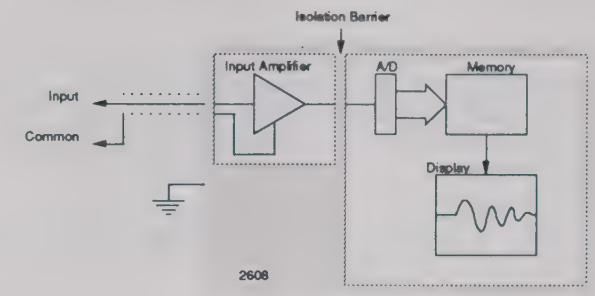


Figure A4d Input Isolation

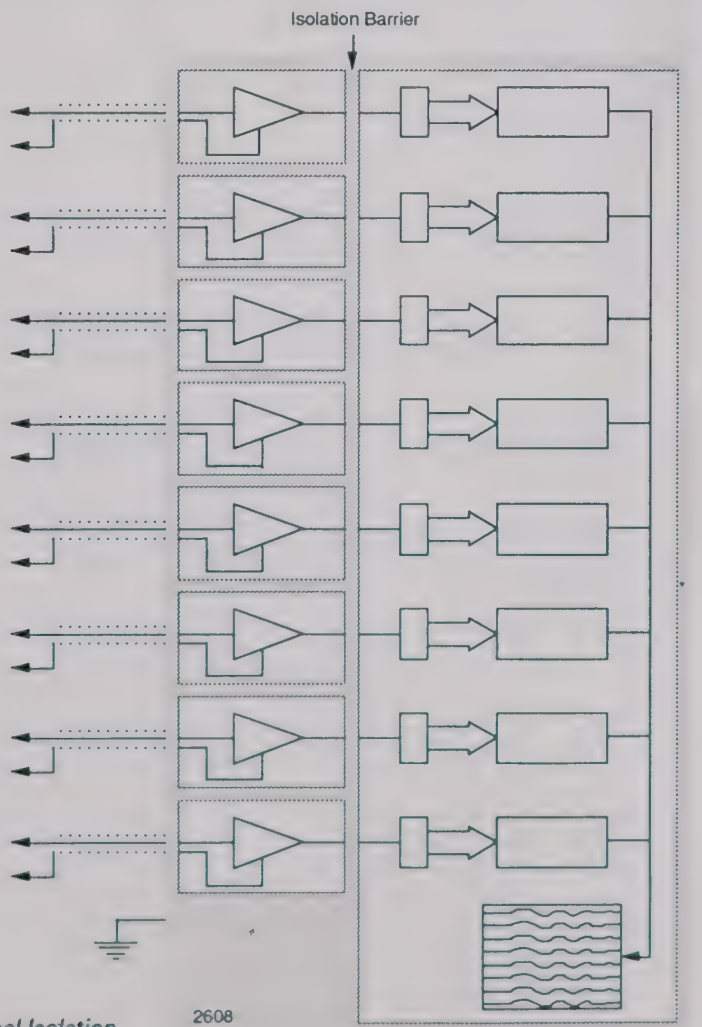


Figure A4e 8 Channel Isolation

The amount of common mode signal which is displayed, will increase both with frequency and the magnitude of the common signal.

In the 2608 the pre-amplifier for each channel input is floated independently, before the signal is digitized. See figure A4d. By reducing the amount of circuitry that is floated, the amount of stray capacitance between the common and ground is minimized.

Since each of the 8 channels has independently isolated input amplifiers, each channel can be floated to a different voltage relative to any other. See figure A4e.

EARTH LOOPS

Earth Loops are another potential problem which can be overcome using isolated inputs. With conventional single ended inputs all the pieces of equipment in the system are earthed to different ground points. It is possible to get "earth loops", because the different ground points are in fact at slightly different potentials. The loop can also act as an aerial and pick up an induced current. See figure A4f.

As previously mentioned, current flowing in these loops can seriously disrupt the circuit under test. Therefore earth loops should be avoided

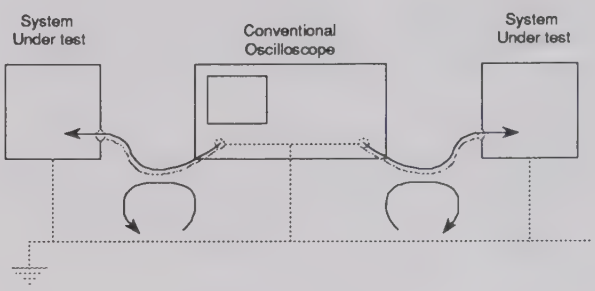


Figure A4f Possible Earth Loops

Isolated inputs break the loop for each input individually, and so prevent earth currents from circulating. See figure A4g.

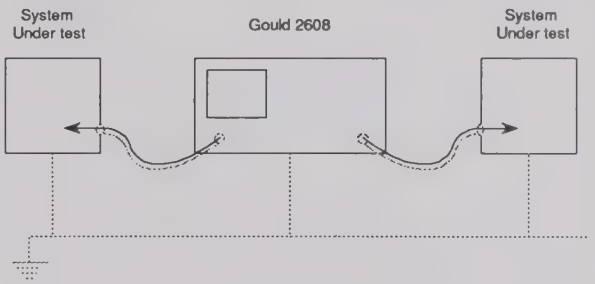


Figure A4g Earth Loops Isolated

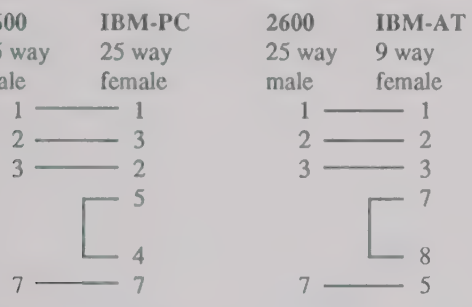
Appendix 5

Interfacing the 2600 to an IBM-PC via the RS423 (RS232)

There are a number of points worth noting when interfacing the 2600 to an IBM-PC or AT via the RS423 (RS232) port.

1. There are two interfaces on the RS423 module.
   Interface 1 (the top one) is an output only interface for use with an HPGL plotter.
   Interface 2 (the bottom one) is the bi-directional control interface for use with a computer.

2. The cable should be wired as follows:



   This bypasses the RTS-CTS handshaking. For large data blocks XON-XOFF handshaking can be used.

3. In most cases Echo & Prompt should be OFF
   This is only for use with dumb terminals, and echoes back every character as it is received. This is unnecessary when using a PC as a controller, and can cause problems if the software is not expecting to receive the echoed characters. When using the SK5526 remote control software package Echo & Prompt should be OFF.

4. To test the interface and connections the following short BASIC program can be run:

```
10OPEN "COM1:9600,N,8,1,DS0,LF" AS #1
20PRINT #1,"VC1"
30INPUT #1,X$
40PRINT X$
50CLOSE #1
```

   This uses the COM1 port on the IBM, and sets up the interface to 9600 baud, no parity, 8 data bits, 1 stop bit, no DSR-DTR handshaking and Line Feed as a terminator. The program then requests the vertical coupling of channel 1, inputs the response from the 2600, and prints it on the screen. For example if channel 1 is AC coupled the program should print VC1=AC, and leave the instrument in RS423 Remote Mode.

5. To read 10k of data into the IBM first load basic with BASICA /C:40000

```
10   DIM TRACE%(10000)
20   OPEN "COM1:9600,N,8,1,DS0,CS0,LF" AS #1
30   PRINT #1,"NB=OCT;WIND=1,10000"
40   PRINT #1,"STR1A"
50   X$=INPUT(8,#1)
60   FOR I%=1 TO 10000
70   TRACE%(I%)=64*VAL(INPUT(1,#1))
     +8*VAL(INPUT(1,#1)) +VAL(INPUT(1,#1))
80   X$=INPUT(1,#1)
90   NEXT I%
100  X$=INPUT(1,#1)
110  CLOSE#1
120  OPEN "TRACE.PRN" FOR OUTPUT AS #2
130  FOR I%=1 TO 10000
140  PRINT #2,TRACE%(I%)
150  NEXT I%
160  CLOSE #2
```

   This sets up the instrument to transmit the 10k bytes from channel 1 in octal format. the data is then read into the integer array TRACE%. When this has been done the data is saved on disc in the file TRACE.PRN. The values saved range from 0 to 255. There are 1000/35 levels per division on the screen. They can be read into Lotus 123 using the Import Numbers function.

Appendix 6 RS423 & GPIB Connections

Pin	Signal	Description	Pin	Signal	Description
1	DIO1	Data input output line 1	13	DIO5	Data input output line 5
2	DIO2	Data input output line 2	14	DIO6	Data input output line 6
3	DIO3	Data input output line 3	15	DIO7	Data input output line 7
4	DIO4	Data input output line 4	16	DIO8	Data input output line 8
5	EOI	End Or Identify	17	REN	Remote Enable
6	DAV	Data Valid	18	(DAV)	Return line
7	NRFD	Not ready for data	19	(NRFD)	Return line
8	NDAC	Data not accepted	20	(NDAC)	Return line
9	IFC	Interface Clear	21	(IFC)	Return line
10	SRQ	Service Request	22	(SRQ)	Return line
11	ATN	Attention	23	(ATN)	Return line
12	Shield		24	Logic Ground	

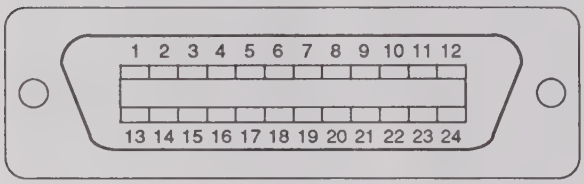


Figure A5c GPIB (IEEE–488) connector pinout

Interface 1 (Plotter)			Interface 2 (Bi–Directional Control)
Pin	**Signal**	**Description**	**Pin**
1	0V	Protective Ground	1
2	RXD	Receive Data	3
3	TXD	Transmit Data	2
4	RTS	Request to Send	4
5	CTS	Clear to Send	5
6	DSR	Data Set Ready	6
7	0V	Signal Ground	7
8	DCD	Data Carrier Detect	8
9	True	RS423 Logic True	9
14	True	RS423 Logic True	14
20	DTR	Data Terminal Ready	20

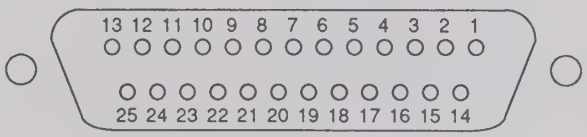


Figure A6b RS423 connector pinout

Miscellaneous Connector

Pin	Signal	Pin	Signal
1	not connected	9	not connected
2	not connected	10	Trigger Out
3	not connected	11	not connected
4	not connected	12	0v
5	0V	13	+5V
6	External Clock Input	14	0V
7	0V	15	0V
8	Sample Clock Out		

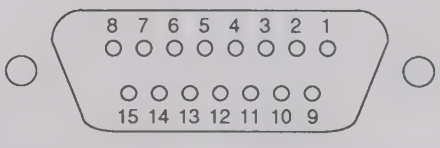


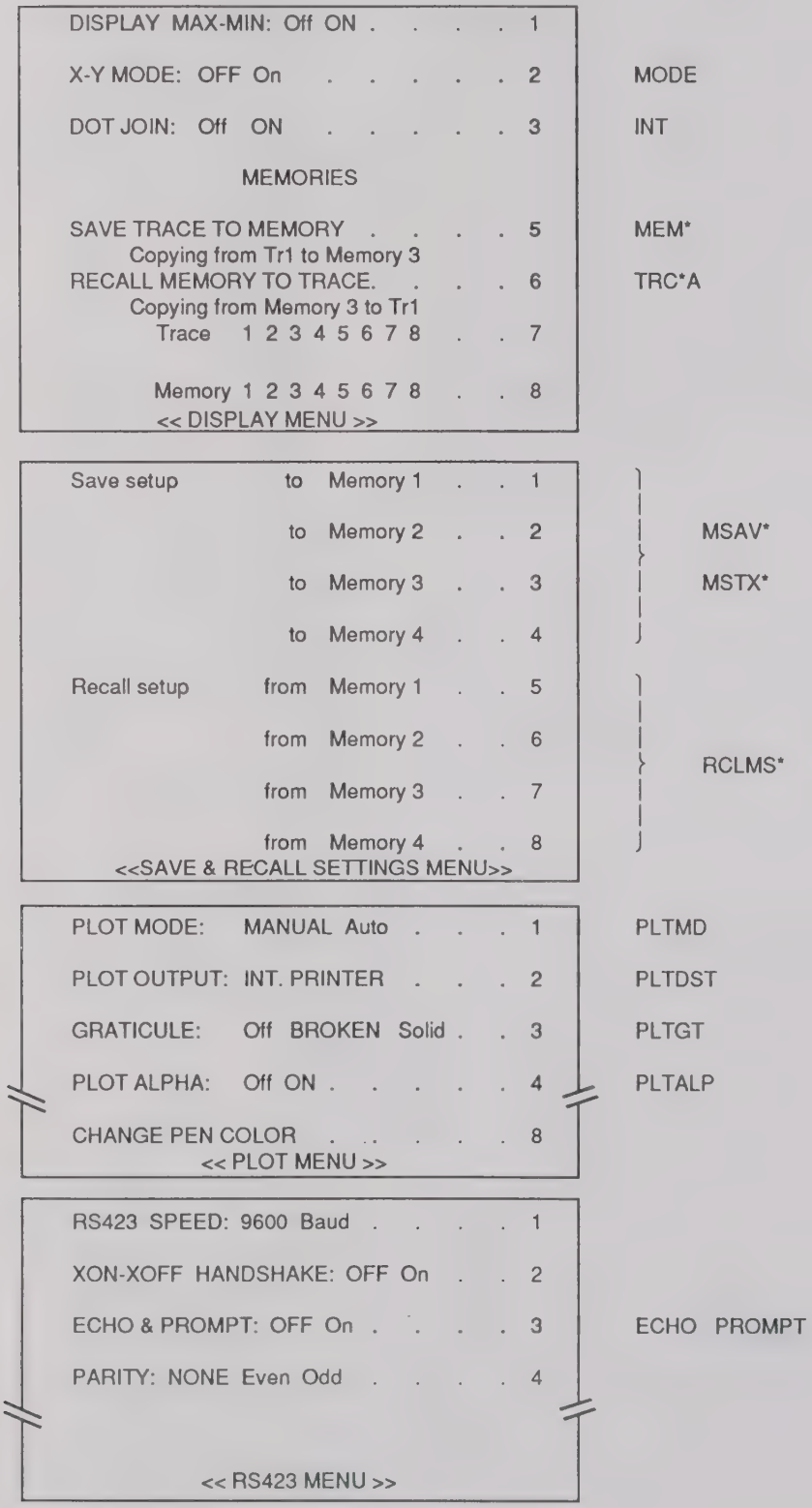
Figure A6c Misc connector pinout

STATUS 1	DISPLAY = MENU1
ACQUISITION / TRIGGER 2	DISPLAY = MENU2
DISPLAY 3	DISPLAY = MENU3
SAVE/RECALL CONTROL SETTINGS . . 4	DISPLAY = MENU4
PLOT 5	DISPLAY = MENU5
SPECIAL FUNCTIONS 6	DISPLAY = MENU6
RS423 INTERFACE 7	DISPLAY = MENU7
OPTION FUNCTIONS 8	DISPLAY = MENU8
<< MASTER MENU >>	

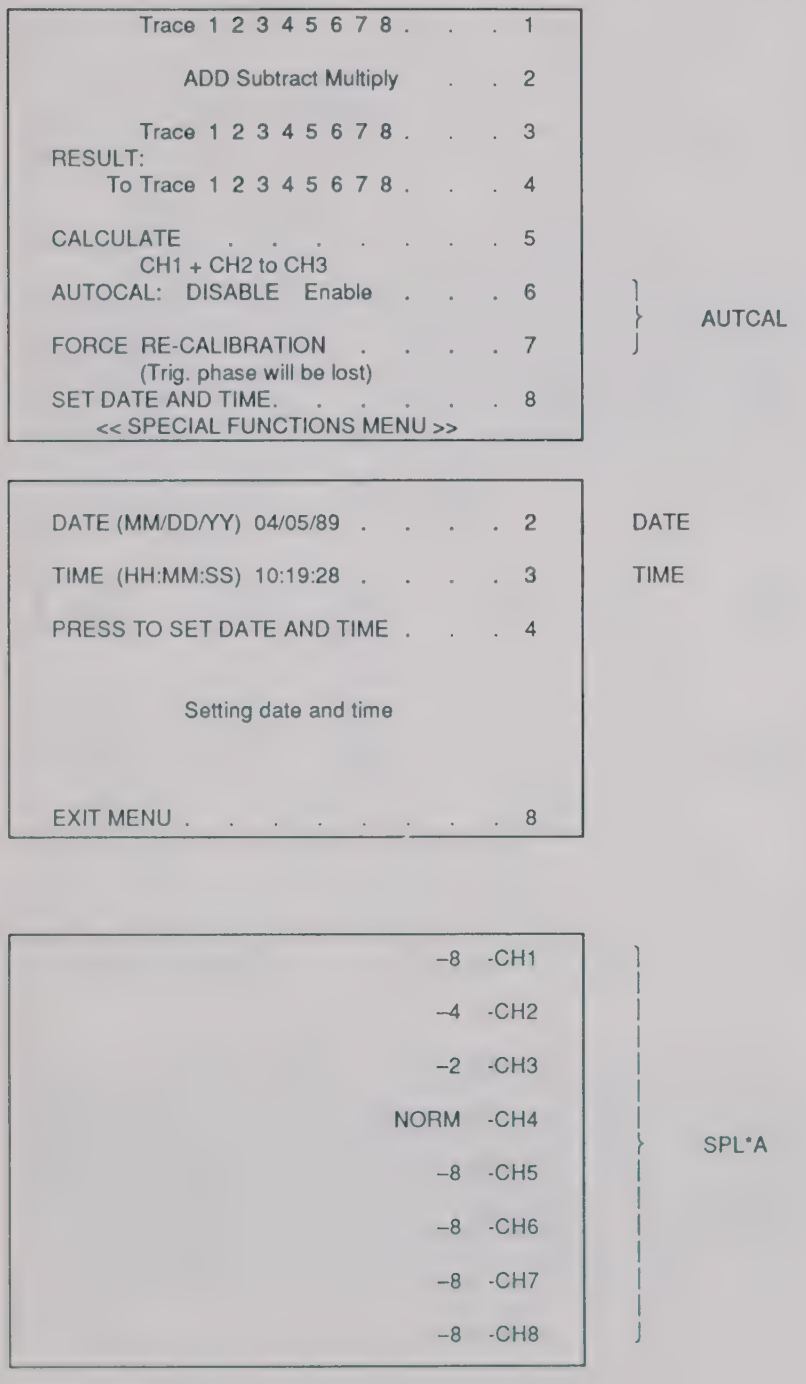
VIEW SETUP: CURRENT 1 2 3 4 . . 1	ALL
CAPTURE MODE : Refresh	
GLITCH DETECT : Off	
SHOW CHANNELS: 1->4 5->8. . . . 3	
CH1 CH2 CH3 CH4	
0.1V 0.1V 0.1V 0.1V	
x1 x1 x1 x1	
–1 –1 –1 –1	
TIMEBASE: 0.1mS X-MAG: x1	
TRIGGER : CH4, AC	
LEVEL : -1.23DIV	
SLOPE : +ve	
0s DELAY	
<< STATUS MENU >>	

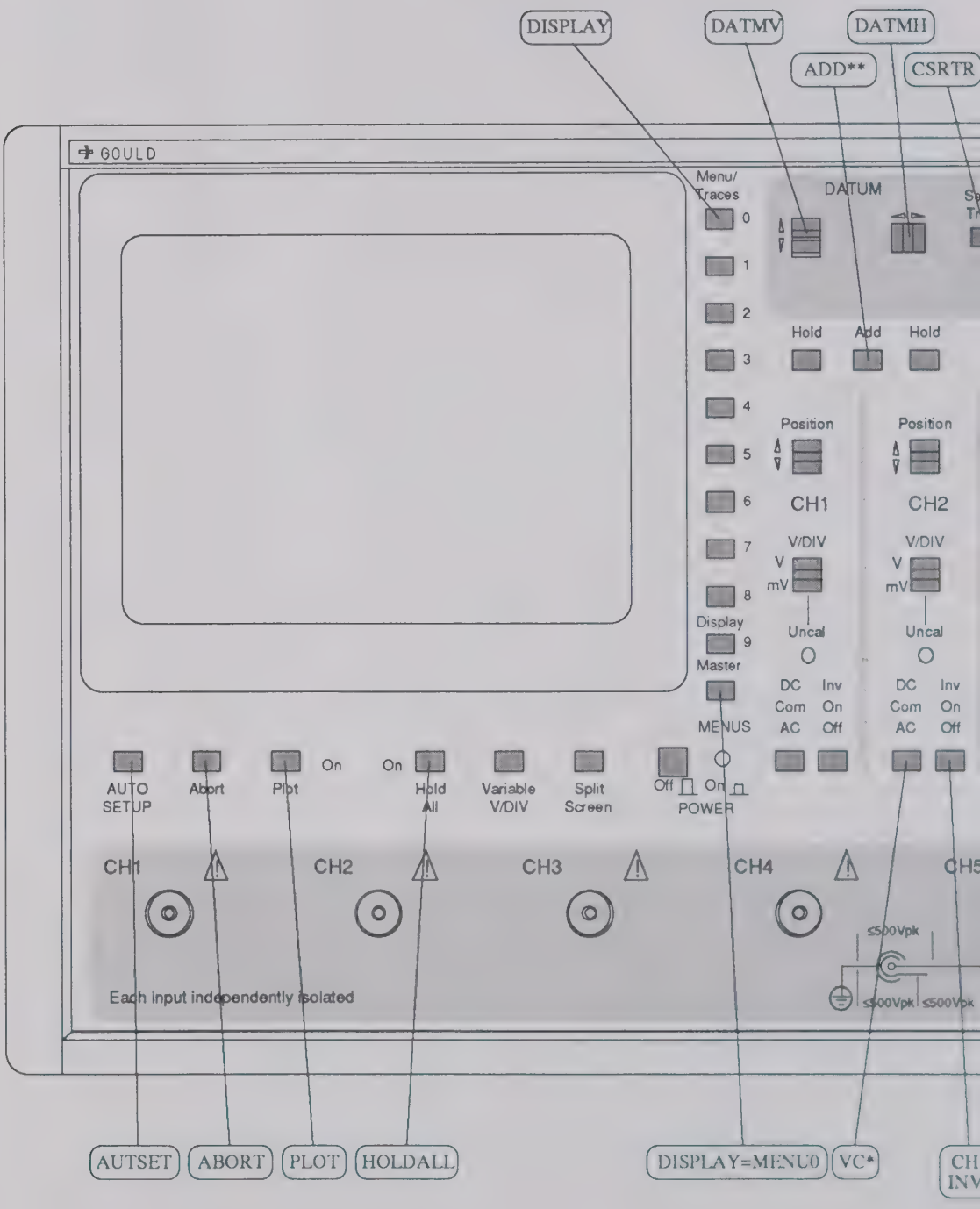
PROBE RATIO: CH 1 2 3 4 5 6 7 8 . . 1	]
x1 x10 x100 x1000 . . . 2	} PBG*]
GLITCH DETECT: Off Max Min MAX-MIN . . 3	GLDET
DUAL TRIGGER: On OFF 4	TDUAL
Pretrig No Delay DELAY . . . 5	]
0036.00µs 6	| TDELA
Max delay at current TB is 100ms	| TEVNT
TIME Events Div by N 7	} TRGMDA |
UNITS: µs ms s 8	|]
<< ACQUISITION / TRIGGER MENU >>	

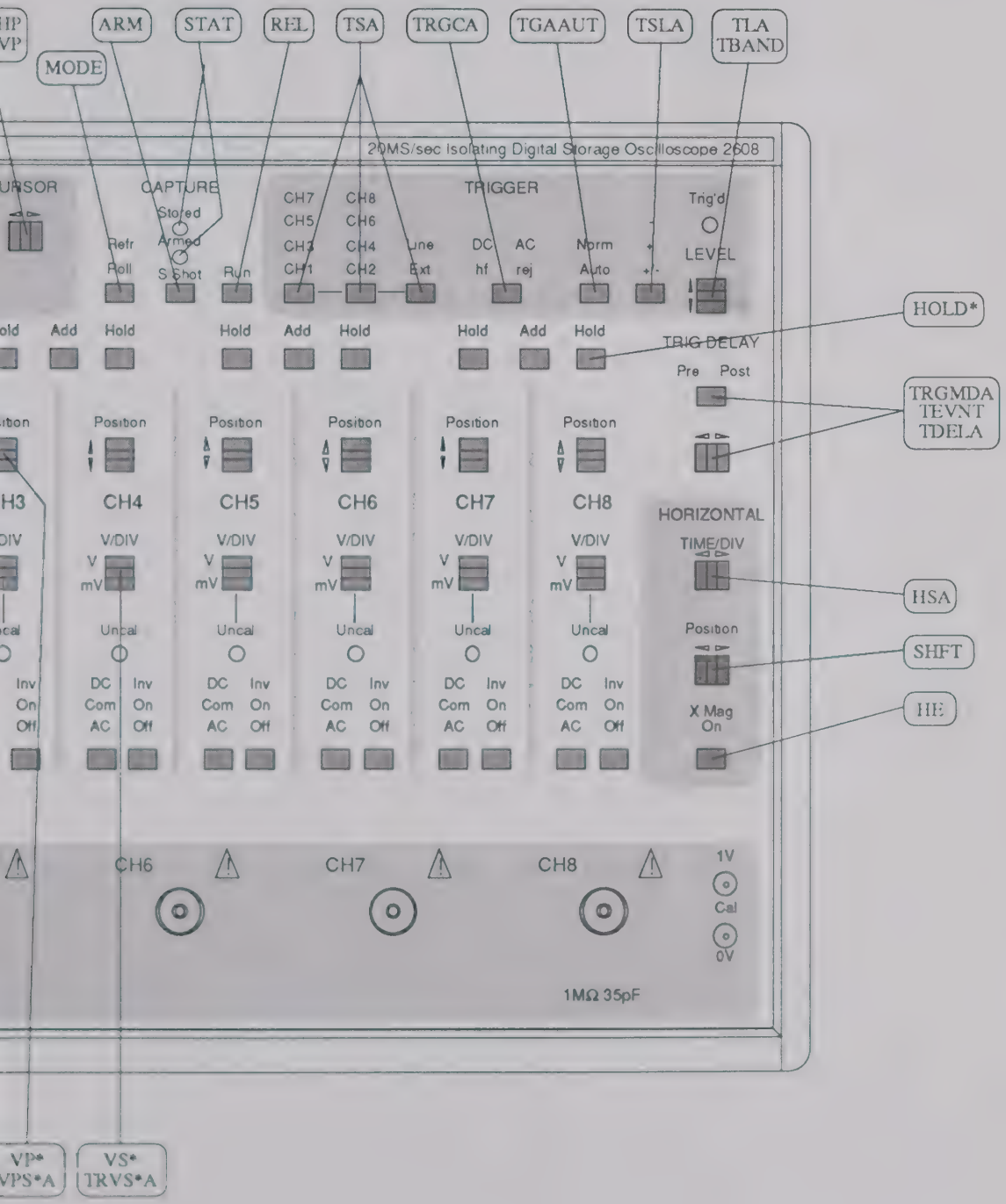
A7


DISPLAY MAX-MIN: Off ON 1
X-Y MODE: OFF On 2
MODE
DOT JOIN: Off ON 3
INT
MEMORIES
SAVE TRACE TO MEMORY 5
MEM*
Copying from Tr1 to Memory 3
RECALL MEMORY TO TRACE. . . . 6
TRC*A
Copying from Memory 3 to Tr1
Trace 1 2 3 4 5 6 7 8 . . 7
Memory 1 2 3 4 5 6 7 8 . . 8
<< DISPLAY MENU >>
Save setup to Memory 1 . . 1
to Memory 2 . . 2
MSAV*
to Memory 3 . . 3
MSTX*
to Memory 4 . . 4
Recall setup from Memory 1 . . 5
from Memory 2 . . 6
RCLMS*
from Memory 3 . . 7
from Memory 4 . . 8
<<SAVE & RECALL SETTINGS MENU>>
PLOT MODE: MANUAL Auto . . . 1
PLTMD
PLOT OUTPUT: INT. PRINTER . . . 2
PLTDST
GRATICULE: Off BROKEN Solid . . 3
PLTGT
PLOT ALPHA: Off ON 4
PLTALP
CHANGE PEN COLOR 8
<< PLOT MENU >>
RS423 SPEED: 9600 Baud 1
XON-XOFF HANDSHAKE: OFF On . . 2
ECHO & PROMPT: OFF On 3
ECHO PROMPT
PARITY: NONE Even Odd 4
<< RS423 MENU >>

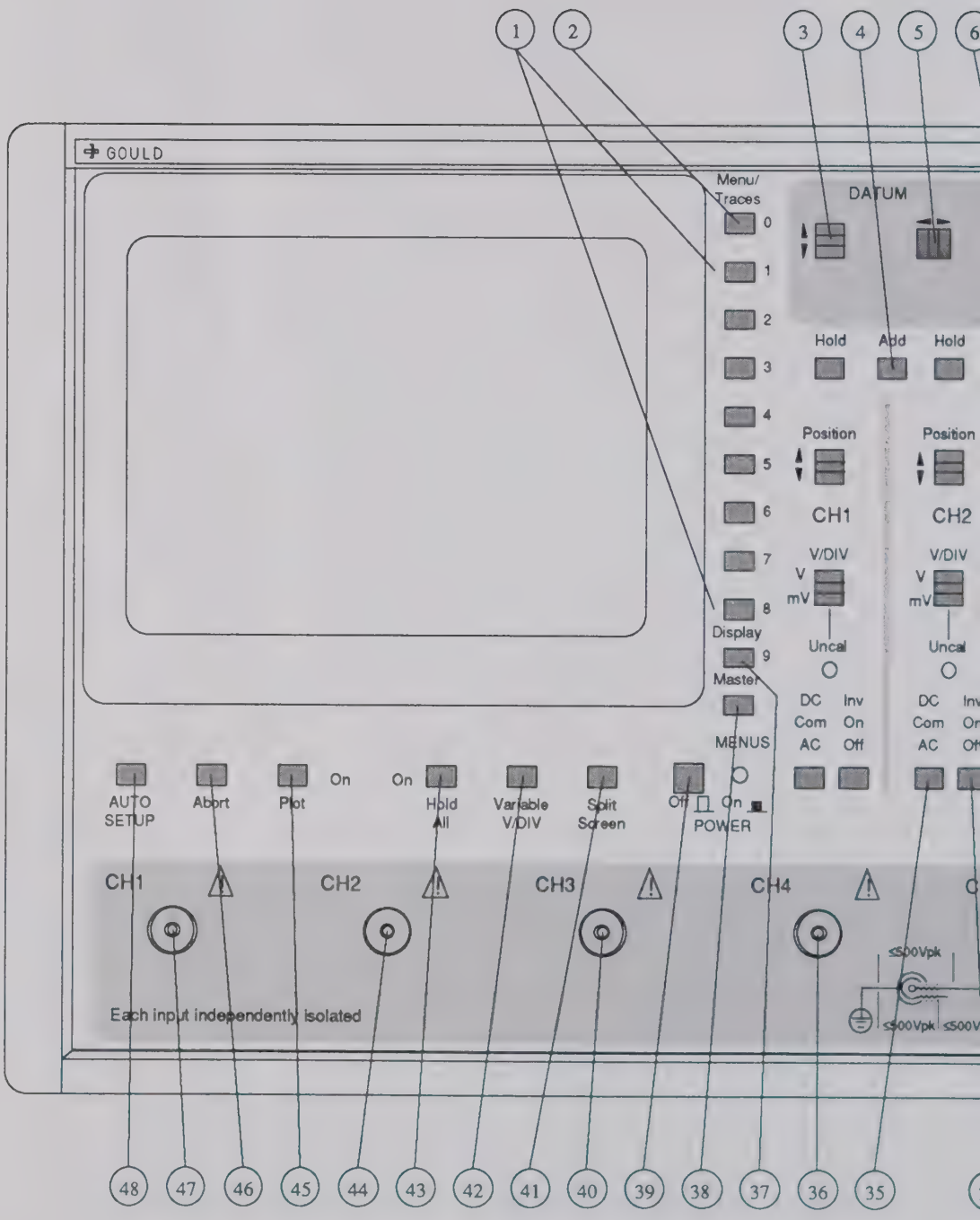
A7

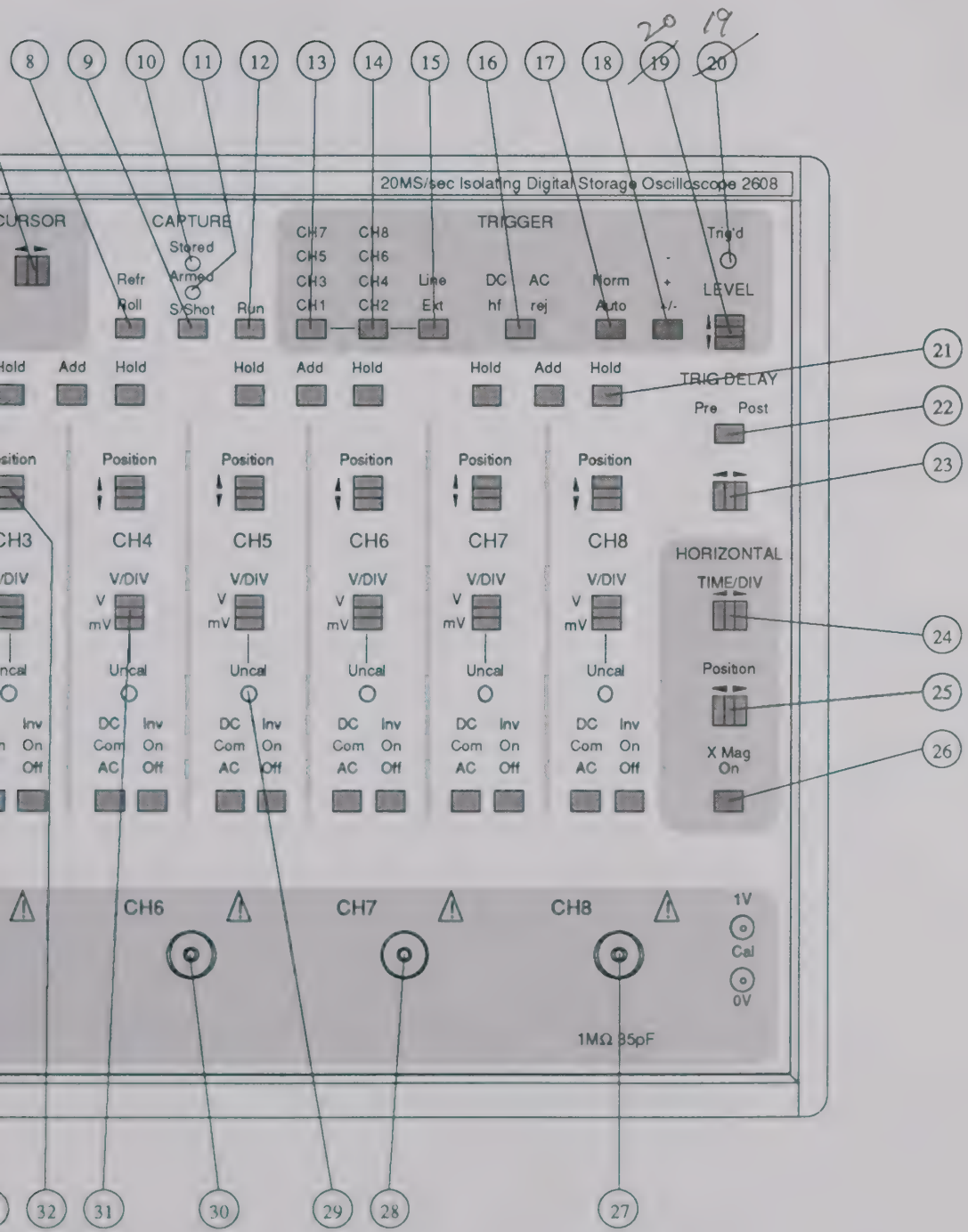

Trace 1 2 3 4 5 6 7 8 . . . 1
ADD Subtract Multiply . . 2
Trace 1 2 3 4 5 6 7 8 . . . 3
RESULT:
To Trace 1 2 3 4 5 6 7 8 . . . 4
CALCULATE 5
CH1 + CH2 to CH3
AUTOCAL: DISABLE Enable . . . 6
FORCE RE-CALIBRATION 7
(Trig. phase will be lost)
SET DATE AND TIME. 8
<< SPECIAL FUNCTIONS MENU >>
AUTCAL
DATE (MM/DD/YY) 04/05/89 2
TIME (HH:MM:SS) 10:19:28 3
PRESS TO SET DATE AND TIME . . . 4
Setting date and time
EXIT MENU 8
DATE
TIME
–8 -CH1
–4 -CH2
–2 -CH3
NORM -CH4
–8 -CH5
–8 -CH6
–8 -CH7
–8 -CH8
SPL*A


DISPLAY
DATMV
DATMH
ADD**
CSRTR
GOULD
Menu/
Traces
DATUM
0
1
2
3
4
5
6
7
8
Display
9
Master
MENUS
Hold
Add
Hold
Position
Position
CH1
CH2
V/DIV
V/DIV
V
mV
V
mV
Uncal
Uncal
DC
Com
AC
Inv
On
Off
DC
Com
AC
Inv
On
Off
AUTO
SETUP
Abort
Plot
On
On
Hold
All
Variable
V/DIV
Split
Screen
Off
On
POWER
CH1
CH2
CH3
CH4
CH5
≤500Vpk
≤500Vpk
≤500Vpk
Each input independently isolated
AUTSET
ABORT
PLOT
HOLDALL
DISPLAY=MENU0
VC*
CH
INV


ARM
STAT
REL
TSA
TRGCA
TGAAUT
TSLA
TLA
TBAND
MODE
20MS/sec Isolating Digital Storage Oscilloscope 2608
CURSOR
CAPTURE
Stored
Armed
S Shot
Refr
Roll
Run
TRIGGER
CH7
CH5
CH3
CH1
CH8
CH6
CH4
CH2
Line
Ext
DC
hf
AC
rej
Norm
Auto
+
+/-
Trig'd
LEVEL
Add
Hold
TRIG DELAY
Pre
Post
HOLD*
TRGMDA
TEVNT
TDELA
Position
CH3
CH4
CH5
CH6
CH7
CH8
V/DIV
V
mV
Uncal
Inv
On
Off
DC
Com
AC
HORIZONTAL
TIME/DIV
HSA
SHFT
X Mag
On
HE
CH6
CH7
CH8
1V
Cal
0V
1MΩ 35pF
VP*
VPS*A
VS*
TRVS*A

A7


GOULD
Menu/
Traces
0
1
2
3
4
5
6
7
8
9
Display
Master
MENUS
DATUM
Hold
Add
Hold
Position
Position
CH1
CH2
V/DIV
V
mV
Uncal
DC
Com
AC
Inv
On
Off
AUTO
SETUP
Abort
Plot
On
On
Hold
All
Variable
V/DIV
Split
Screen
Off
On
POWER
CH1
CH2
CH3
CH4
Each input independently isolated
≤500Vpk
48
47
46
45
44
43
42
41
40
39
38
37
36
35


20MS/sec Isolating Digital Storage Oscilloscope 2608
CURSOR
CAPTURE
Stored
Armed
S/Shot
Refr
Roll
Run
CH7
CH5
CH3
CH1
CH8
CH6
CH4
CH2
Line
Ext
TRIGGER
DC
hf
AC
rej
Norm
Auto
-
+
+/-
Trig'd
LEVEL
Hold
Add
TRIG DELAY
Pre
Post
Position
CH3
CH4
CH5
CH6
CH7
CH8
V/DIV
V
mV
Uncal
DC
Com
AC
Inv
On
Off
HORIZONTAL
TIME/DIV
X Mag
1V
Cal
0V
1MΩ 35pF
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

Index.

† For an index to the GPIB and RS423 commands, see section 5.3.1

‡ For an index to the waveform processor GPIB and RS423 commands, see section 5.4.3

ABORT †, 5.4.1, 5.4.2
Abort 2.7
AC, Channel 1.5.3
    Trigger 2.1.3
AC/Com/DC 1.5.3
Acquiring traces 5.4.1
ACRMS ‡
ADD †
Add 1.7.4
Adding programmable sequence steps 5.4.2
Address, GPIB 3.10
ADEST ‡
Alias 1.6.2
ALL †
Alpha intensity 3.12
AOPND ‡
AREA ‡, 5.4.1
Area measurement 5.4.1
Arithmetic operations on waveforms 5.4.1
ARM †
Armed 2.3.2
AROP ‡
ASCALE ‡
ASRC ‡
Assertive commands 5.2
Attenuator, Sensitivity 1.7.1
    Volts/div 1.7.1
AUTCAL †
Auto setup 1.5.1
Auto trigger 2.1.6
Auto capture and save 5.4.1
Auto/norm 2.1.6
AUTSET †
Averaging 5.4.1

Band 2.1.5
Bandwidth 4
    Trigger 4
Base, number 5.2
Binary data transfers 5.2
BL †
BLL †
Block 5.2
    Length 5.2
Brightness 3.12

Cal 1.7.3, 3.13
CALC ‡
Calibration 4
    Timebase 4
    Vertical 4
Capture (and Repeat) 5.4.1, 5.4.2
CAPTURE ‡
Capture Facilities 2.3
CCAL †
CH †
Change pen color 2.7
Channel, Hold 2.3.1
    Selection 1.5.2
CMODE ‡
Com (Common) 1.5.3
Command, List 5.3.1, 5.3.2
    Syntax 5.3.2
    Types 5.2
Computer Interfacing Appendix 5
Connecting the waveform processor 5.4
Continuous (Run) 2.3.2
Control Summary 6
Coupling, Input 1.5.3
    Trigger 2.1.3
    Vertical 1.5.3
CSCALE ‡
CSRHP †
CSRTR †
CSRVP †
Cursor Mode 5.4.1
Cursor 5.4
    Measurements 2.5
    Selection 2.5.1
    Commands

Data Transfers 5.2
DATE †
DATMH †
DATMV †
Datum 2.5.1, 5.4, 5.4.1
dB scaling/measurement 5.4.1

dB/% 5.4.1
DC, Channel 1.5.3
Trigger 2.1.3
Dec 5.4.1
Decimal Data Transfers 5.2
Delay by events 2.2.3
Delay by time 2.2.2
Delay trigger 2.2
Deleting programmable sequence 5.4.2
Direct action assertive commands 5.2
DISPLAY †
Display Max–Min 3.5
Display Menu 3.5
Divide by N 2.2.4
Dot joining 3.5
Dust 1.1.5
DUTY ‡

Earthing 1.1.3
ECHO †
Echo and prompt 3.10
Editing programmable sequence 5.4.2
Entering programmable sequences 5.4.2
Enveloping 5.4.1
EOI 5.2, †
Events, trigger delay by 2.2.3
Executing programmable sequence 5.4.2
Exit 5.4.2
Expansion, Horizontal 1.6.4
EXT 2.1.7
External trigger input 2.1.7

F (function) 5.4
Fall time measurement 5.4.1
FFT 5.4.1
FFT Menu 5.4.1, 5.4.2
FFT ‡
FFTHSC ‡
FFTMEAS ‡
FFTPTS ‡
FFTTRC ‡
FFTVSC ‡
FFTWIND ‡
FILTER ‡
Filtering 5.4.1
Focus 3.12
Fourier transform menu 5.4.1
Freezing a trace 2.3.1

FREQ ‡
Frequency 5.4.1
Range 1.1.7
Sampling 1.6.1
Frequency measurement 5.4.1
Fuse requirements 1.1.8

Gain, variable 1.7.3
GLDET †
Glitch detect 3.4
GPIB (IEEE-488) 3.10, 5.2
Address 3.10
Commands 5.3
Command summary 5.3.1
Command detail 5.3.2
Grounding 1.1.3

Handshake (RS423) 3.10
Hanning window (FFT) 5.4.1
HE †
HELLO †
HELLOWP ‡
HELP †
Helpful hints 1.9
Hexadecimal data transfers 5.2
HOLD †
Hold 2.3.1
HOLDALL †
Horizontal, Adjustment 1.6
Datum line 2.5.2
Expansion 1.6.4
Magnification 1.6.4
Modes 2.3
Position 1.6.3
Scaling
Shift 1.6.3
HPS ‡
HSA †

I/O interfaces
I/O Master Menu
IEEE commands 5.4.3
IEEE control 5.4.3
IEEE-488 3.10, 5.2, 5.3, 5.3.1, 5.3.2
Command summary 5.3.1
Command detail 5.3.2
INC 5.4.1

INIT ‡
Initialise 5.4
Input Coupling 1.5.3
Installing the waveform processor 5.4
INT †
Integrate 5.4.1
Integration 5.4.1
Interfaces, input/output 3.10
Interpolation 3.5
Interrogative commands 5.2
INTG ‡
INV †
Invert 1.5.2, 5.4.1
INVPS ‡
Isolated Inputs 1.1.2, 1.2, 2.6

Learn 5.4.2
Level 2.1.4
LIM ‡
Limits testing 5.4.1
LIMST ‡
Linear interpolation 3.5
Listing measurements on plotter 5.4.1
Listing programmable sequences 5.4.2
Live parts 1.1.4
LOCAL †
LOWLIM ‡

Magnification/attenuation 5.4.1
Mass data format 5.2
Master Menu 3.1.3, 3.2
Math Menu 5.4.1, 5.4.2
MAX ‡
Max/Min 5.4.1
Max/Min detect function 3.4
MEAN ‡
Measurement scroll 5.4.2
Measurements 5.4.1
Measurements, cursor 2.5
MEM †
MEM*HS †
MEM*VS †
Memory, Trace 3.5
    Setup 3.6
Menu/trace 3.1.2
MIN ‡
MODE †
MSAV †
MSTX †

NB †
Next 5.4.2
Norm 2.1.6
Number base 5.2
Numeric Keys 3.1.1, 5.4

Octal data transfers 5.2
Off, channel 1.5.2
On, Channel 1.5.2
Option functions menu 5.4.1
OVER ‡
Overshoot measurement 5.4.1

Parity 3.10
PBG †
PEAK ‡
Peak signals 3.4
Peak to Peak voltage measurement 5.4.1
Pen color change 2.7
Percentage scaling/measurement 5.4.1
PERIOD ‡
PH+ †
Phase shift 2.2.4
PH– †
PLOT 5.4.1, 5.4.2
PLOT †
Plot 2.7
    Destination 3.7
    Graticule 3.7
    Menu 3.7
Plotter, Internal, color 2.7
    Internal, thermal 2.7
Plotting waveforms 5.4.1
PLTALP †
PLTDST †
PLTGT †
PLTLN †
PLTMD †
Position 5.4.1
    Horizontal 1.6.3
    Vertical 1.7.2
Post storage functions 5.4.1
Power, Button 1.4
    Requirements 1.1.7
Pre-trigger 2.2.1
PRESH ‡
Preshoot measurement 5.4.1
PREV 5.4.2
Print On/Off 5.4.1, 5.4.2

PRINT ‡
Probe gain 3.4
Programmable sequences 5.4.2
    adding sequence steps 5.4.2
    deleting sequence 5.4.2
    editing sequence 5.4.2
    entering sequences 5.4.2
    executing sequence 5.4.2
    listing sequences 5.4.2
    measurement scroll 5.4.2
    single stepping sequence 5.4.2
PROMPT †
Prompt and echo 3.10
Pulse Width 5.4.1

RCLMS †
Recall, Setup 3.6
    Trace 3.5
Records 5.2
Rectangular window 5.4.1
Reference memories 5.4.1
    auto capture and save 5.4.1
    clearing 5.4.1
    recall from 5.4.1
    saving to 5.4.1
    selection 5.4.1
    size 5.4.1
Reference voltage for dB/% measurement 5.4.1
REFM ‡
Refresh mode 2.4
REL †
Restore 5.4.1
RESTORE ‡
RISE ‡
Rise/fall percentage 5.4.1
Risetime measurement 5.4.1
RISEPER ‡
RMHS ‡
RMS 5.4.1
RMS ‡
RMTYPE ‡
RMVS ‡
Roll mode 2.4
Rotate 3.12
RS232/RS423 3.10, 5.2
    Commands 5.2
    Command summary 5.3.1
    Command detail 5.3.2
Run 2.3.2
RUNSEQ ‡

S/Shot 2.3.2
S/Step 5.4.2
Safety 1.1
Samples per division 1.6.1, 1.6.4
Sampling rate 1.6.1
SAVE ALL 5.4.1
Save Lower Limit 5.4.1
Save One 5.4.1
Save Upper Limit 5.4.1
Save setup 3.6
Save/Recall Menu 3.6
SAVEALL ‡
SAVEONE ‡
Scaling, Horizontal 1.6.1
    Vertical 1.7.1
Select Trace 5.4
Sensitivity 1.7.1
Separators 5.2
SEQU ‡
Service requests 5.2
Set % 5.4.1
Set Average 5.4.1
Set Envelope 5.4.1
Set Ref 5.4.1
SETAVG ‡
SETENV ‡
SETREF ‡
Setup 3.6
SHFT †
Single stepping programmable sequence 5.4.2
Single-shot capture 2.3.2
Slope, trigger 2.1.5
Special functions 3.8
Speed (RS423) 3.10
Spikes 1.1.2, 3.4
SRQV †
STAT †
Status Menu 3.3
Stored 2.3.2
Stores, Display trace 3.5
    Setup 3.6
STR*A †
Supply Voltages 1.1.7
Sweep rate 1.6.1

TBAND †
TDELA †
TDUAL †
Temperature 1.1.6
Test Limits 5.4.1

TEVNT †
TGAAUT †
TIME †
Time datum line 2.5.2, 5.4
Time measurement 5.4.1
Time, trigger delay 2.2.2
Time/div 1.6.1
Timebase, Calibration 4
    Selecting 1.6.1
    Setting 1.6.1
TLA †
Trace, Hold 2.3.1
    On/Off 1.5.2
    Intensity 3.12
    Plot 2.7
    Position 1.6.3, 1.7.2
    Recall 3.5
    Rotate 3.12
TRC*A †
TRGCA †
TRGMDA †
TRHS*A †
Trig'd 2.1
Trigger
    Auto 2.1.6
    Band 2.1.5
    Bandwidth 4
    Control 2.1
    Coupling 2.1.3
    Delay 2.2
    Delay by events 2.2.3
    Delay by time 2.2.2
    Divide by N 2.2.4
    Dual 2.1.2
    Inputs, external 2.1.7
    Level 2.1.4
    Menu 3.4
    Mode 2.1.6
    Normal 2.1.6
    Pre 2.2.1
    Sensitivity 4
    Slope 2.1.5
    Source 2.1.1
TRVS*A †
TSA †
TSLA †
TV Mode 5.4.1
TVMODE ‡
TXT †

Uncal 1.7.3, 3.13
UPLIM ‡

V&T 5.4.1
V/div 1.7.1
Variable Gain 1.7.3, 3.13
Variable V/Div 1.7.3, 3.1.5, 3.13
VC †
Ventilation 1.1.5
Vertical, Adjustment 1.7
    Calibration 4
    Coupling 1.5.3
    Datum line 2.5.2
    Position 1.7.2
    Shift 1.7.2
View setup 3.3
Voltage, Datum line 2.5.2
    Signal 1.1.2
    Supply 1.1.7
Voltage datum 5.4, 5.4.1
Voltage measurement 5.4.1
VP †
VPS*A †
VS †
VTMODE ‡

WAIT 5.4.1, 3.10
Waveform processor 5.4
Waveform measurements 5.4.1
Waveform Processor 5.4
WIDTH ‡
WIND †
Windows (FFT) 5.4.1

X magnification 1.6.4
XY mode 2.4, 3.5

Y Mag 5.4.1
YCAL ‡
YMAG ‡
YSCALE ‡

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Contents

Introduction

1 Getting Started

2 Advanced Features

3 The Menus

4 Performance Checking

5 Options

6 Alphabetical Summary

A1 Error Messages

A2 Specification

A3 Glossary

A4 Floating Inputs

A5 RS423 to PC Interfacing

A6 RS423 & GPIB Pin–outs

A7 Front Panel & Menus GPIB Equivalents

A8 Front Panel Picture

Index

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